The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VI, No. 12 December, 1915

CONTENTS

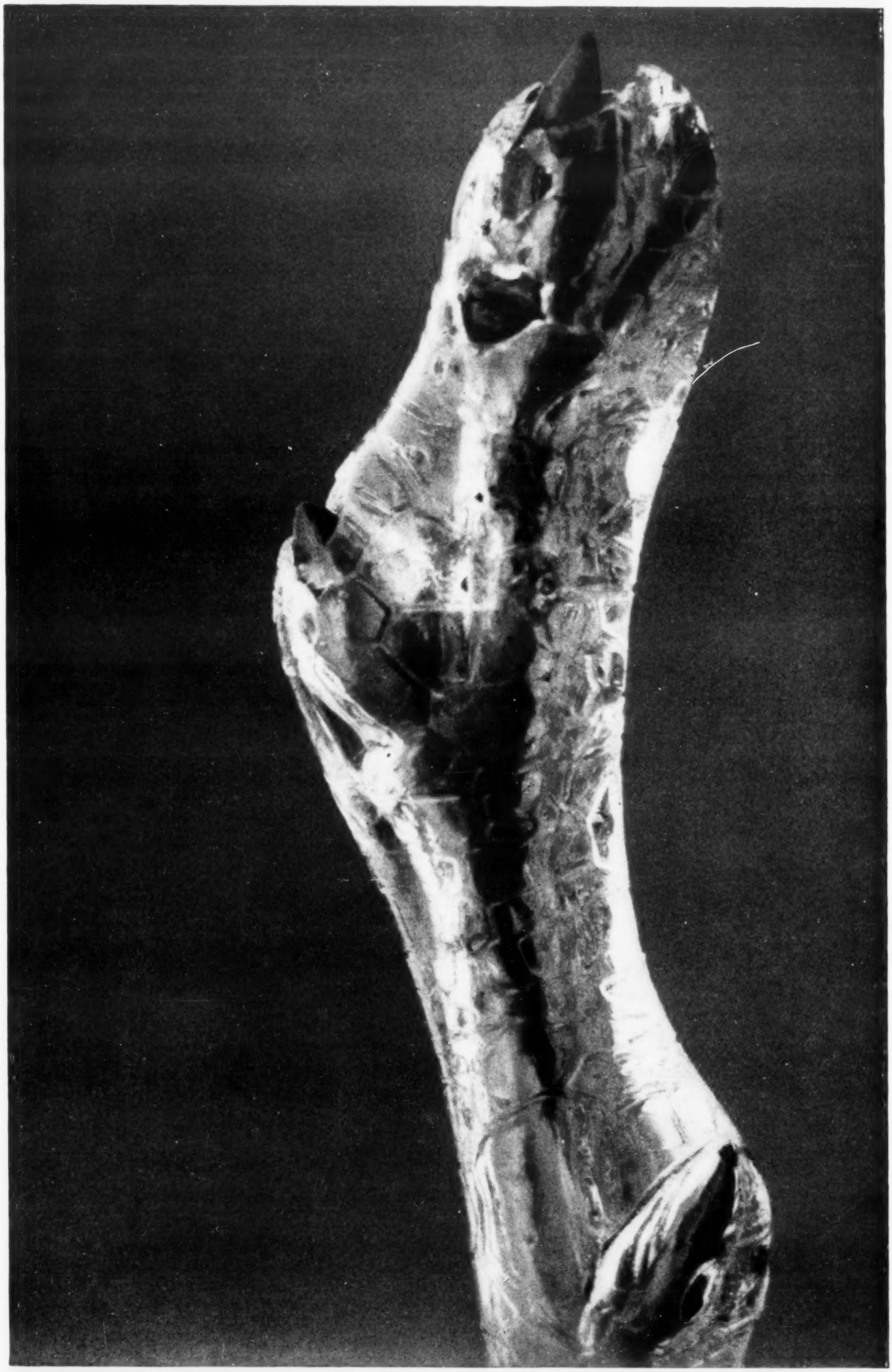
Ice Melting from a Twig—Frontispiece 530
What is a Breed?, by Orren Lloyd-Jones 531
Studies of Citrous Fruits 537
Value of Negative Eugenics, by Edwin G. Conklin 538
New Publications:
The American Pet Stock Standard of Perfection, by J. Henri Wagner 541
Inheritance of a Profile 541
The Marking Factor in Sunflowers, by T. D. A. Cockerell 542
Inheritance of Sex in Strawberries 545
Natural Selection in War, by Roswell H. Johnson 546
Pure Lines in Cotton 548
The Self-Sterility Problem, by E. J. Kraus 549
Home Grown or Foreign Seed 557
Plant Breeding in Cuba. by F. S. Earle and Wilson Popenoe 558
Genetic Study of Apples 568
Rebuilding the Leghorn 569
Title Page of Vol. VI 571
Index to Vol. VI 573

The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912. Contents copyrighted 1915 by the American Genetic Association. Reproduction of articles or parts of articles permitted provided proper credit is given to author and to the Journal of Heredity (Organ of the American Genetic Association), Washington, D. C.

Date of issue of this number, November 26, 1915.

ICE MELTING FROM A TWIG



Ice forms on trees during a rain, particularly when the temperature of a thin layer of air on the ground is below freezing, but the temperature of the air above is warmer, thus preventing the rain from turning to sleet. In this photograph (highly enlarged) the ice has begun to melt, and in doing so clearly reveals its crystalline structure, the typical angles seen being those of a hexagon. From a photograph by David Fairchild. (Frontispiece.)

WHAT IS A BREED?

Definition of Word Varies with Each Kind of Livestock, and is Based Almost Wholly on Arbitrary Decision of Breeders—Some Strange Contradictions—The Meaning of "Pure-Bred"[1]

ORREN LLOYD-JONES
Associate Professor of Animal Husbandry, Iowa State College, Ames, Iowa

IT IS the custom in legal documents to achieve unmistakable clearness of meaning by multiple repetition of words, and synonymous words and phrases. This method of securing clearness is distasteful to the scientific writer, and discussions and dissertations aiming to define the scope and set the limits of scientific words are numerous and lengthy. Some classic biological examples of terms of this sort are the words: species, hybrid, race, variety, etc. A kindred term which has served its purpose long and well is the word *breed*, and it may be worth while to give this word further attention.

The term "breed" is in such common use that most persons, on invitation, would be quick to explain its meaning and even ready to offer an exact definition of the word. For those who take pleasure in formulating terse, concise definitions of common terms the above word presents an interesting problem. If the person is a scientist, he must especially be on his guard, for it must be remembered that this is a term which arose among breeders of livestock, created, one might say, for their own use, and no one is warranted in assigning to this word a scientific definition and in calling the breeders wrong when they deviate from the formulated definition. It is their word and the breeders' common usage is what we must accept as the correct definition.

This sounds simple enough, but when we begin a search to discover what the "common usage" is we are dismayed at the varied and loose meanings which the breeders have given to this word.

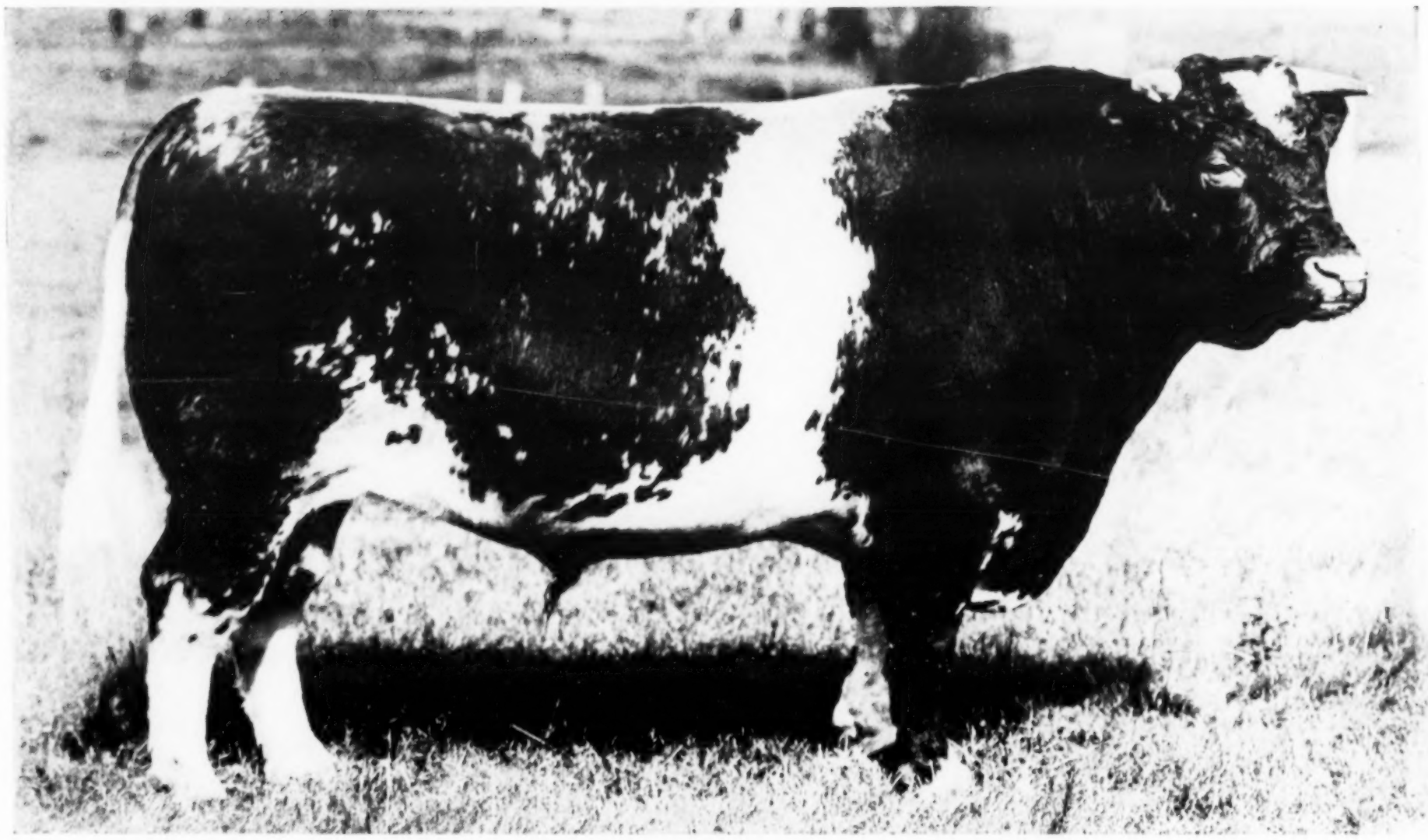
We find that a great divergence of opinion, as to what a breed may include before it must be subdivided, exists between the breeders of different classes of livestock. For instance, Shorthorn cattle can be any of four colors, and Percheron horses have a choice of half a dozen, but each breed remains a homogeneous unit without subdivisions on the basis of color. With smaller animals the lines are more finely drawn. In case of poultry, for example, the colors are kept separate, as distinguishing features of a strain, under the name of varieties, but several of these varieties are grouped together as a breed. We have white, barred, buff, or partridge varieties of the Plymouth Rock breed, and of Wyandottes I believe there are about a dozen varieties differing from each other in color, pattern, feathering, or comb shape.

Thus in poultry the breeds are composite, made up of several subdivisions, although the range of variation may be no greater, or even far less, than that found within a single breed of the large mammals. Breeders of "pet stock" rabbits, guinea-pigs, and especially of dogs, use the word "breed" in a very reckless fashion, and an attempt to divine their exact understanding of the term would be in many cases well nigh hopeless.

But to add to the confusion, breeders of the same class of livestock in different parts of the world do not always adhere to the same usage. The case of the Leicester sheep serves as a good illustration of this point.

In England there are two sorts of sheep which are connected by a certain

[1] Presented to the Agricultural Club of Iowa State College in February, 1915.



RINGMASTER, GRAND CHAMPION SHORTHORN BULL, 1913

The Shorthorn is a breed with wide limits; it takes in a number of different colors and types which in other branches of the animal industry would be considered distinct breeds. But when it comes to lack of horns, the Shorthorn breeders draw the line, as the next illustration shows. (Fig. 1.)

degree of kinship in "blood," but which are now, and for the past sixty years have been, recognized as distinct breeds. The two breeds referred to are the English Leicester and the Border Leicester. They differ from each other in size, ancestry (the Border Leicester having received some characters from the Cheviot breed), general activity, fecundity, and manner of wooling, to an unmistakable extent. Both the Scotch Highland Society and the English Agricultural Society provide separate classes and awards for them at the agricultural shows, and there are two distinct registration associations, each of which maintains a flock book for its own breed. In America, however, we speak only of the Leicester breed of sheep. The two sorts are shown together at fairs, often freely crossed, and are registered in the same flock book. They are here simply regarded as different "families" of the Leicester breed.

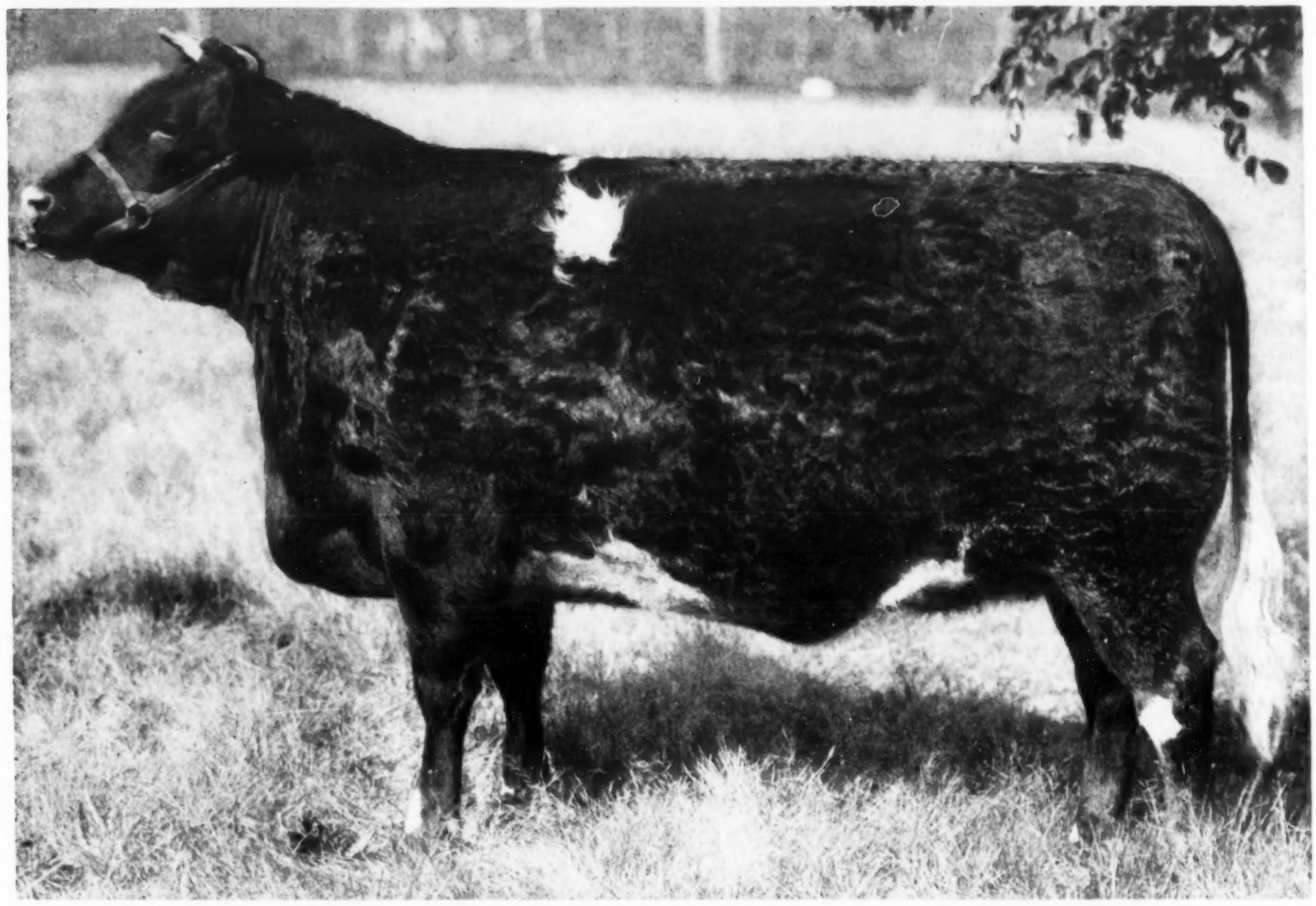
There is no fixed, commonly accepted degree of difference which serves to typify and separate the breeds. This can be illustrated by citing cases of the two extremes. First, types which differ widely between themselves may be included within the boundaries of a single breed.

Poland China breeders recognize the distinct varieties which they speak of as the "large type" and "small type." The differences between the two are constant, deep-seated, and striking, but the members of both types are all of the undivided Poland China breed. A similar "dimorphic" condition exists within the limits of the Jersey breed of cattle.

But perhaps the most striking case of this sort is furnished by the Shorthorn breed of cattle. The Milking Shorthorn is profoundly different from the strictly Scotch-bred beef animal. The difference between these two types involves, besides three possible color factors, pronounced and easily recognized peculiarities of shape and also of function. Furthermore, these two types usually differ clearly from each other in ancestry. The pedigree of the typical Milking Shorthorn will generally trace

SULTAN'S CREED, GRAND CHAMPION POLLED DURHAM BULL, 1913

Genetically, the Polled Durham is nothing but a Shorthorn without horns. This difference is due to a single factor in heredity, as the analysis of breeding experiments shows. It is one of the smallest differences on record which have sufficed for the establishment of a distinct breed, and is a difference which may exist between full brothers who resemble each other in every other respect. A comparison of the above animal with the Shorthorn shown in Fig. 1 will show that they conform minutely to the same type. The horns form the only significant difference between them, and they are of little significance as far as the value of the animal is concerned. Sultan's Creed and Ringmaster might actually have been born twins—it is a genetic possibility—but they must go through life as members of different breeds because of the difference in one factor, which affects the horns. Photograph from the owner, J. H. Miller, Peru, Ind. (Fig. 2.)



MONARCH'S VICTORIA, A BEEF TYPE SHORTHORN

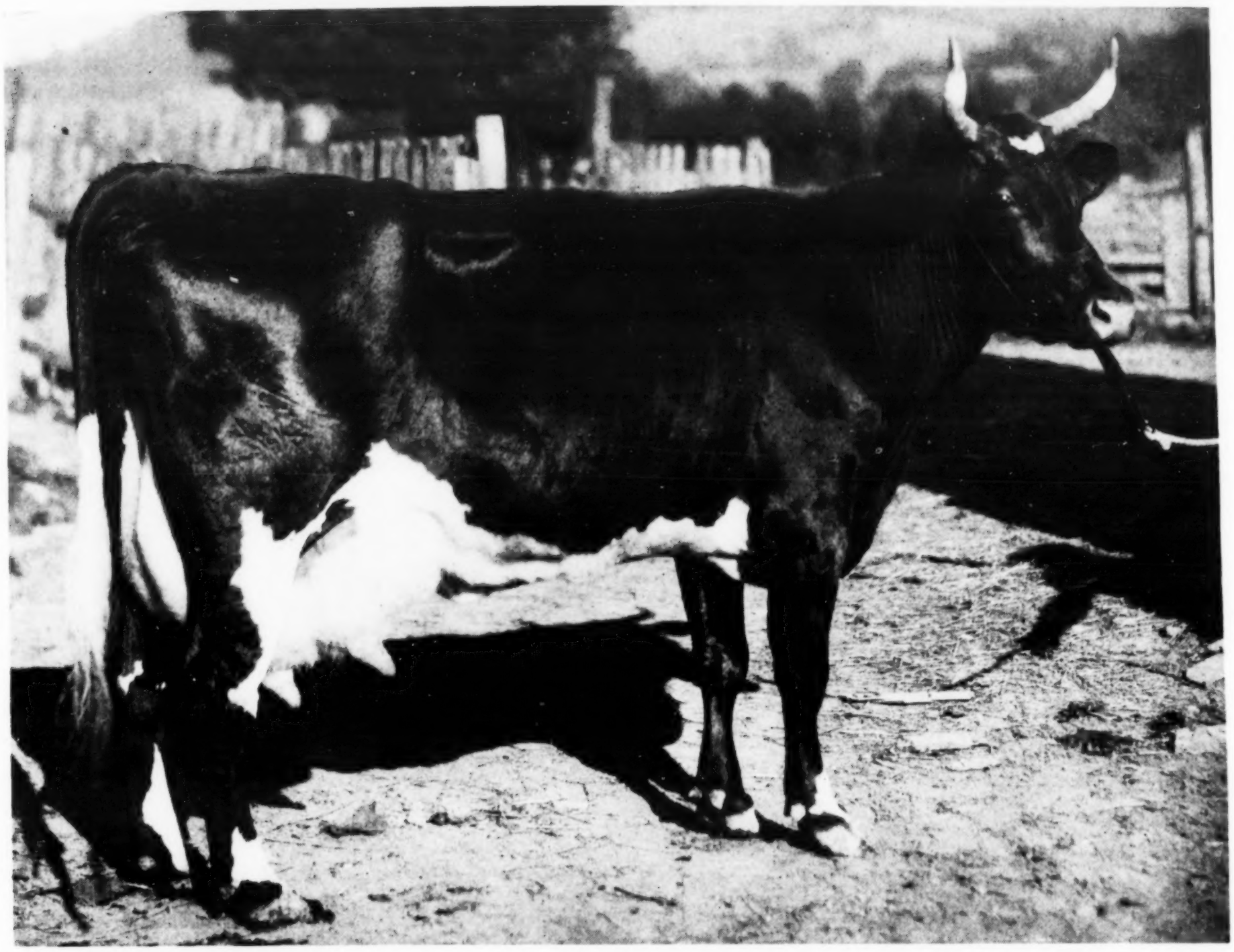
Champion Shorthorn heifer at the Chicago International Stock Show in 1913, she represents the prevailing American idea of a good Shorthorn, intended to produce meat, not milk. Every line of her form proclaims the fact that she is not a dairy cow. But if anyone thinks that the Shorthorn "breed" cannot produce dairy animals he is mistaken, as the illustration opposite will prove. (Fig. 3.)

back to the breeding of Thomas Bates, while the specialized beef animal shows predominantly in its pedigree only animals of Cruickshank or Booth breeding, the lines of lineage frequently running entirely separate for the past fifty years. But the limiting confines are very elastic and, despite these far-reaching differences, the integrity of the Shorthorn breed has not yet been disrupted on this basis.

TRIVIAL BREED BARRIERS

Second: On the other hand, types which show minute similarity may belong to separate breeds. Back in the Miami Valley of Ohio, in the mother country of the world-famous Poland China hog, there are many herds of Poland Chinas that retain the spotted pattern characteristic of all early Poland hogs. These pigs boast the same ancestry and the same type as their aristocratic "pure-bred" cousins. They are the true, reliable, rent-paying Poland China sort; paint over their white spots and they would defy detection in many a high class Poland China herd. But their spots make them outcasts, and to enable them to get inside the boundaries of a breed it is necessary that they set up a standard of their own. As a result, the Spotted Poland China breed is a reality.

It is particularly interesting that Shorthorn breeders, so generous and broad-minded in accepting wide variants into the ranks of their breed and so reluctant in permitting a cleavage of the group, also furnish an example under this head. For a variation has appeared among Shorthorn cattle which is deemed of sufficient moment for creating a separate breed. In this case, the excuse for splitting the breed is a simple difference of structure, which is known to act as a simple Mendelian unit character, *i.e.*, the



MAMIE'S MINNIE, A MILK TYPE SHORTHORN

This animal represents a family of Shorthorns that has been bred with a view to milk production, not beef production. Her record in 1913 was 14,838 pounds of milk, in 1914, 16,201 pounds, a record better than that of many fine members of the Jersey or other dairy breeds. Between this animal and the one shown on the opposite page there is scarcely a single feature of type or conformation in common. The differences between a Jersey and Guernsey cow, for example, are negligible in comparison. Yet these two cows are "breed" sisters, and might appear on the same page of the herd book. Such a contrast as this illustrates graphically the point that a breed is whatever its adherents want to call it; it is not a biological division. Photograph from the owners, May and Otis, Granville Centre, Pa. (Fig. 4.)

polled condition. Animals may be identical in form, function and even ancestry, but if they differ in respect to the presence or absence of horns, one may belong to the Polled Durham breed and the other will be merely a Shorthorn. These two types are exhibited separately in the shows, they are recorded in separate herd books and are recognized officially and in text-books of the day as distinct breeds of cattle.[2]

Lastly, we find that what is ordinarily considered as the most reliable feature to which we may hold fast in our conception of a breed, that is, degree of kinship among animals of a group, is not at all a safe means to delimit a breed. The oldest and most honored of the registry associations—that maintained for Shorthorn cattle in England—accepts today as members of the breed animals which have but fifteen-sixteenths of Shorthorn ancestry. The rules of the Morgan Horse Association admit the entry of animals with only one thirty-second of the blood of Justin

[2] It should be said, however, that many good Polled Durhams are entered in the Shorthorn herd book, as well as in that of their own breed. This double registry is not altogether unknown iu some other breeds.

Morgan, with certain reservations as to the other ancestors; while until recently the American Saddle Horse Association was ready to receive animals from whatever source or breeding as bona fide breed members if they were able to successfully execute five distinct gaits under the saddle. Furthermore, animals which themselves had never traveled under the saddle, but had produced several "performers," were eligible.

TWINS OF DIFFERENT BREEDS

The above cases are examples of animals with very slight degree of kinship belonging to the same breed, but the opposite may also be true. That is, animals with "100% the same breeding" may belong to separate breeds. We will again choose an illustration from the Shorthorn breed. Two animals may have the same sire and the same dam, and yet one will be registered in the Polled Durham herd book, while the other will be limited to the Shorthorn registry. It might easily happen that two calves would be actually born as twins and yet these two animals would be known and referred to throughout their lives as members of two distinct so-called "breeds."

It will be said that the Leicesters are grouped together in this country for purely economic reasons; that the American saddle horse is merely repeating the historic stages of every new breed in opening its books so wide; that livestock men when "pinned down" will confess the Polled Durham to be simply a sub-breed; and that the Poland China breeders are privileged to draw up whatever rules they choose in regulating their own registration.

The above comments are true in every case, but the situation remains unchanged. It is simply the usage of the word *breed* which has been called to account in the above paragraphs and not the usefulness of the boundary lines which breeders have set up between the different groups of animals. With the latter, the writer does not here take issue. It is plain, however, that mere statements to the effect that two animals are members of the same breed, or that two other animals belong to different breeds, have very little value in themselves as means of describing the likeness or unlikeness in type or kinship of the two animals. It is further necessary to know just what breed or breeds are referred to before one can form an idea of the degree of difference or similarity to be expected between the two animals.

The word *breed* has no biological meaning; it is bandied about by different classes of men in different places in the world without uniform regard to either type or kinship of the animals referred to. Its whole meaning is entirely dependent on the action of the rules committee of the breed association. A breed is whatever the breeders want to call it, there are no natural boundaries, and no arbitrary ones that are universally accepted.

A breed is a group of domestic animals, termed such by common consent of the breeders, and in formulating a universal definition no person can go very much further without usurping a right which is not justly his.

WHAT PURE-BRED MEANS

The significance of the derivative, *pure-bred*, may well be considered at this time. When a group of animals becomes sufficiently set off to be called by common consent a breed, a number of breeders unite themselves into an association. A charter is secured from the Government, a breed record or register is established, and rules of eligibility for entry into the same are set down in the by-laws. Thus the breed is definitely delimited and from this time, but not before this time, the term *pure-bred* can be correctly and safely applied to individual specimens. There is no natural boundary and breeders must await the arbitrary and official one. *A pure-bred is an animal entered or eligible to entry in the association books, or descended from such animals.*

The history of the Percheron breed of horses is interesting in this connection. Draft horses from France were early imported into this country and in 1876

an association was formed for their registry. But it soon developed that more than one kind of draft horse existed in France and that a motly array of horses was being offered for entry into the American book. A bitter dispute arose concerning eligibility of horses for record. All admitted that a *breed* existed, but no one could give a satisfactory definition of a *pure-bred*. Finally in 1883, acting on the insistent requests of American importers, the French breeders established a Record Association. They accepted as foundation animals only those draft horses found in the six provinces which comprised the old district of La Perche.

At once American breeders stipulated that imported horses, to qualify for entrance in the American Association books, must first be accepted by the French Society. This ended the embarrassing uncertainty; a breeder could now lay claim to the title "pure-bred" for a horse and could successfully establish his right to do so. Pure-breds were created by definition as a result of this action by the Society. But though the sale value of these horses was greatly increased, their biological nature was not changed. This word again depends for its meaning on the verdict of a body of men; it is in fact a civil, rather than a biological word. Biologically a horse may carry enough heritable traits to make him a high caste pure-bred Percheron, but if his ancestors lived across the line in Boulogne rather than in one of the six provinces originally specified by the French rules committee, he cannot claim that title, but must remain a Boulonnais.

Studies of Citrous Fruits

Study of citrous fruits at the California Agricultural Experiment Station has convinced the investigators that:

1. In all naturally fertile varieties of orange trees, self-pollination is the rule and cross-pollination unnecessary.
2. Viable pollen is either wanting or very scarce in parthenocarpic varieties—*i.e.*, varieties which produce fruit without seeds; the navel orange, for example.
3. The time required for complete fertilization after pollination varies with the variety from thirty hours in the Satsuma orange to four weeks in the wild *Citrus trifoliata*.
4. Normal embryo sacs are occasionally produced in the Washington Navel and Satsuma oranges. If such oranges happen to be pollinated with viable pollen from a nearby fertile variety, the result is the production of a few seeds in a navel orange. In other cases, even if pollination should take place, no seeds are produced because the embryo sacs in the navel orange disintegrate. In other words, navel oranges are seedless in most cases merely because they are not effectively pollinated and yet are able to produce fruit without such pollination.

Finally, the investigators have come to the conclusion that the origin of parthenocarpic citrus varieties—the navel orange, the seedless pomelo, etc.—is to be found in hybrids between naturally fertile varieties. The same explanation has been given for the seedlessness of the commercial banana and many other fruits. Such a theory, if it can be developed, opens the way for the commercial production of seedless fruits in many species where simple selection would be of little practical value. Extensive hybridization work is being taken up in citrus, while the study of purity of varieties has also received attention.

VALUE OF NEGATIVE EUGENICS

Measures That Are Possible Are Decidedly Worth Taking but Must Not Be Expected to Cause Any Great Amount of Race Betterment—Difficulties in the Way of Constructive Eugenics[1]

EDWIN G. CONKLIN
Professor of Biology, Princeton University, Princeton, N. J.

NO WELL-informed person doubts that the principles of heredity and evolution apply to man as well as to the lower organisms and in spite of much controversy with respect to the importance of natural selection in evolution, I make bold to assert that no other principle has yet been suggested of equal importance with this, and that the elimination of the unfit affords not only the only natural explanation for the existence of fitness, but also the only means by which breeders have been able to improve domesticated animals and cultivated plants. The only possible control which mankind can exercise over the production of improved races of lower organisms or of men lies in the elimination from reproduction of the less favorable variations which are furnished by nature. For it has become more and more clear in recent years that, while environment exercises a great influence over the development of the individual, its influence on the germ plasm or the hereditary characteristic of the race is relatively slight and in general is not of a definite or a specific character. Probably environment may under certain circumstances modify the germ plasm, but there is no evidence that good environment will produce good modifications, and bad environment bad modifications in this hereditary substance. Consequently, the only method which is left to man for improving races is found in sorting out the favorable varieties from the unfavorable ones which are furnished by nature. If the human race is to be permanently improved in its inherited characteristics, there is no doubt that it must be accomplished in the same way in which man has made improvements in the various races of domesticated animals and cultivated plants.

Fortunately, or unfortunately, the methods which breeders use cannot be rigidly applied in the case of man. It is possible for breeders to eliminate from reproduction all except the very best stocks, and this is really essential if evolution is to be guided in a definite direction. If only the very worst are eliminated in each generation, the standard of a race is merely maintained, but the more severe the elimination is, the more does it become a directing factor in evolution. This may be illustrated by a diagram in which variations in all directions are represented by lines radiating from a central point. These lines may be thought of as being individually distinct, as in the "pure line" concept. If only those lines are blocked which lead in one direction, the center of radiation or "mode" would be but slightly changed in successive generations. But if all lines are blocked but those which lead in one particular direction, the mode will be rapidly shifted in that direction in succeeding generations. Therefore the value of selection as a directing factor in evolution depends on its severity.

MAINTAINING THE LEVEL

In the case of man, however, even the most enthusiastic eugenicists have never proposed to cut off from the possibility of reproduction all human stocks except the very best, and if only the very worst stocks are thus elimin-

[1] Paper read before the Eugenics Section, American Association for the Study and Prevention of Infant Mortality, Philadelphia, Pa., November 11, 1915.

ated, we must face the conclusion that practically all that can be accomplished will be to preserve the race at its present level. The ecstatic visions of those eugenicists who look forward to a world of supermen to be produced by this method of eliminating from reproduction the worst human stocks, can be regarded only as irridescent dreams, impossible of fulfillment. It is impossible, then, to apply rigidly to man the methods of animal and plant breeders. Society cannot be expected to eliminate from reproduction all but the very best lines. The great majority of mankind cannot be expected voluntarily to efface itself. The most that can be hoped for is that the great mediocre majority may eliminate from reproduction a very small minority of the worst individuals.

Furthermore, other and perhaps even more serious objections to the views of extreme eugenicists are to be found in human ideals of morality. Even for the laudable purpose of producing a race of supermen, mankind will probably never consent to be reduced to the morality of the breeding-pen with a total disregard of marriage and monogamy. The geneticist who has dealt only with chickens or rabbits or cattle is apt to overlook the vast difference between controlling reproduction in lower animals and in the case of man where restraints must be self-imposed.

Another fundamental difficulty in breeding a better race of men is to be found in a lack of uniform ideals. A breeder of domestic animals lives long enough to develop certain races and see them well established, but the devotee of eugenics cannot be sure that his or her ideals will be followed in succeeding generations. The father of Simon Newcomb is said to have walked through the length and breadth of Nova Scotia seeking for himself a suitable mate, but neither he nor any other eugenicist could be sure that his descendants would follow a similar course, and long continued selection along particular lines must be practiced if the race is to be permanently improved. Mankind is such a mongrel mixture, and it is so impracticable to exercise a strict control over the breeding of men, that it is hopeless to expect to get pure or homozygous stocks except with respect to a very few characters and then only after long selection.

But granting all these difficulties which confront the eugenicist, there is no doubt that something may be gained by eliminating the worst human kinds from the possibility of reproduction, even though no great improvement in the human race can be expected as a result of such a feeble measure. The question which has been assigned to me on this occasion is "How the Number of Births of Children Receiving a Faulty Heritage from their Parents May Be Reduced?" Strictly speaking, there is no one who does not receive a faulty heritage, at least in some respects; "there is none perfect, no not one." But there are some whose heritage is so faulty that they constitute a menace to society, and it is doubtless to these that this question refers. There are large numbers of persons, loosely called "defectives," in modern society, and it seems to be a question whether they are not actually increasing in number. This increase may be due, however, to a more accurate recognition and classification of defectives than prevailed formerly. There is no clearly and sharply defined class of defectives, but human populations show every gradation from the highest and most efficient individuals to the lowest and worst; strictly speaking, defectives may be said to include all individuals below the average, from subnormals to monsters. In general all defectives are shorter lived than normals, and the more serious the defect the shorter the life. The worst monstrosities die in the early stages of development, others live but a short time after birth, and none of these ever leaves offspring. Only those defectives in whom abnormalities are relatively slight ever reproduce. Nature has thus erected an insuperable barrier against the propagation of the worst.

ONE EFFECT OF CHARITY

Nevertheless a good many defectives survive in modern society and are capable of reproduction who would have perished in more primitive society before

reaching maturity. In the most highly civilized States the lives of these unfortunates are preserved by charity, and in not a few they are allowed to reproduce, and thus natural selection, the great law of evolution and progress, is set at naught. It is within the power of society to eliminate from reproduction this dependent class.

How can the number of defectives born from defective parents be reduced? Evidently if these defects are hereditary it can be done only by preventing their breeding, since in modern society defectives cannot be destroyed by Spartan methods. Many ways have been recommended and a few have been tried to accomplish this end, but they all come under two categories: (1) Segregation to prevent the union of the sexes, (2) sterilization or other means to prevent conception following sexual union. Such methods if rigidly applied to all defective or abnormal persons would doubtless reduce the number of "children receiving a faulty heritage from their parents," but since it is impossible for reasons indicated above to apply these methods to any except the most seriously defective class, which is usually dependent upon public care or private charity, and since in general the birth rate at present among such defectives is not large, no great change in the number of births of defective children through such elimination need be anticipated. And this is especially true since children inherit not merely the traits which their parents show, but also those family traits which are carried along in the germ plasm in a latent or recessive form, waiting only for an opportunity to become patent. The study of heredity shows that the normal brothers and sisters, or even more distant relatives, of defective persons may carry the defect in their germ plasm and may transmit it to their descendants though not showing it themselves. Such persons are more dangerous to society than the defectives themselves. And yet it is probably impossible rigidly to exclude them from reproduction

Finally, it is usually difficult and often impossible to decide whether a given defect is due to heredity or to environment; if it is due to the latter the methods adopted for its prevention must be wholly different from what they would be if it is due to the former cause. Experiments on guinea-pigs, rabbits and other animals show that serious defects may be produced in offspring by the action of alcohol and drugs on either or both of the parents before conception, and Forel with his wide experience in such matters does not hesitate to maintain that the effect of alcohol on either or both of the parents at the time of conception is one of the most fruitful causes of monstrous or defective children. No doubt there are many other environmental causes of defects in children, such as infection, malnutrition, injury, etc., at various stages in their development.

Dr. Henry H. Goddard, of the Training School at Vineland, N. J., has kindly furnished me with the following figures regarding the mental condition, so far as it has been investigated, of the parents of the inmates of that institution:

Number of families investigated	337 or 100%
Both parents feeble-minded	57 or 16.9%
One parent feeble-minded and other normal	43 or 12.8%
One parent feeble-minded and other unknown	54 or 16.0%
Family history of feeble-mindedness	154 or 45.7%
Both parents normal	90 or 26.7%
One parent normal, the other unknown	47 or 13.95%
Both parents unknown	46 or 13.65%

I am indebted to Dr. Martin W. Barr of the Pennsylvania Training School at Elwyn, Pa., for an extensive etiological table which he has prepared showing the probable causes of mental defect in more than 4,000 cases, from which I quote the following summaries:

	No. of cases	Percentage
Causes acting before birth	2,651	65.45
Family History of Idiocy and Imbecility ..... 1,030 or 25.43%		
Causes acting at birth	186	4.59
Causes acting after birth	1,213	29.96
Totals	4,050	100.

Dr. George Mogridge, Superintendent of the Iowa Institution for Feeble-Minded Children has kindly supplied me with the following figures regarding the reported mental condition of the parents of persons who have been admitted to that institution, at the same time warning me that such statistics are not altogether reliable:

Number of families investigated	1,701 or 100.0%
Inmates who have both parents feeble-minded	66 or 3.88%
One parent feeble-minded and other normal or unknown	134 or 7.88%
Number with both parents normal	513 or 30.16%
Number with both parents unknown	876 or 51.5%
Insanity in one or both parents	112 or 6.58%

Defects, whether due to heredity or to environment, are multitudinous. Even feeble-mindedness is no simple thing; some persons are born fools, some acquire foolishness, and some have foolishness thrust upon them. Even with apparently good heredity and good environment the children of many excellent people are more or less defective, and at present we know of no means to reduce the number of such mistakes of nature. The eugenicist can sometimes "explain" such mistakes after they have occurred, though unable to predict them before the event. Indeed eugenical explanations are apt to be more convincing and accurate than eugenical prophecy; it is well to have eugenical insurance against having defective children, but it is advisable not to have all your insurance in one company.

NEW PUBLICATIONS

THE AMERICAN PET STOCK STANDARD OF PERFECTION and Official Guide of the American Fur Fanciers' Association. Compiled by J. Henri Wagner, president. American Fur Fanciers' Association, Washington, D. C., 1915; pp. 52, price 50 cents.

Breeders of rabbits, cavies (guinea-pigs), rats and mice are here provided with specifications, such as breeders of other animals and fowls have long enjoyed. In the case of many breeds, a brief account of the origin is given. Diagrams of color pattern and photographs of excellent specimens of each breed increase the value of the book as a work of reference for all who are interested in the smaller kinds of pet stock.

Inheritance of a Profile

At the Casalina estate, near Perugia, Italy, crosses are made between Rambouillet rams and Middle Tiber Valley ewes. The latter have a very convex profile of nose and forehead, as compared with the straight face of the Rambouillet; the results obtained lead to the conclusion that in the first hybrid generation all the crosses have a straight face profile, while the convex profile reappears in the second hybrid generation, in a ratio very nearly following the expectation for a recessive under Mendel's law—namely, one in four.—Carlo Pucci, director of the zootechnical laboratory of the Royal Agricultural Institute of Perugia, in *Il Moderno Zooiatro*, Bologna, April 30, 1915.

THE MARKING FACTOR IN SUNFLOWERS

T. D. A. Cockerell,
University of Colorado, Boulder, Col.

LAST year, working on the coloring matters in sunflowers, I made the unexpected discovery that the rays of a number of perennial species contain a substance which turns bright scarlet or vermillion in caustic potash solution. The annuals give no such reaction, and thus it is evident that although the *visible* colors in life may be exactly the same, there is still something fundamentally different, only revealed by a chemical test.

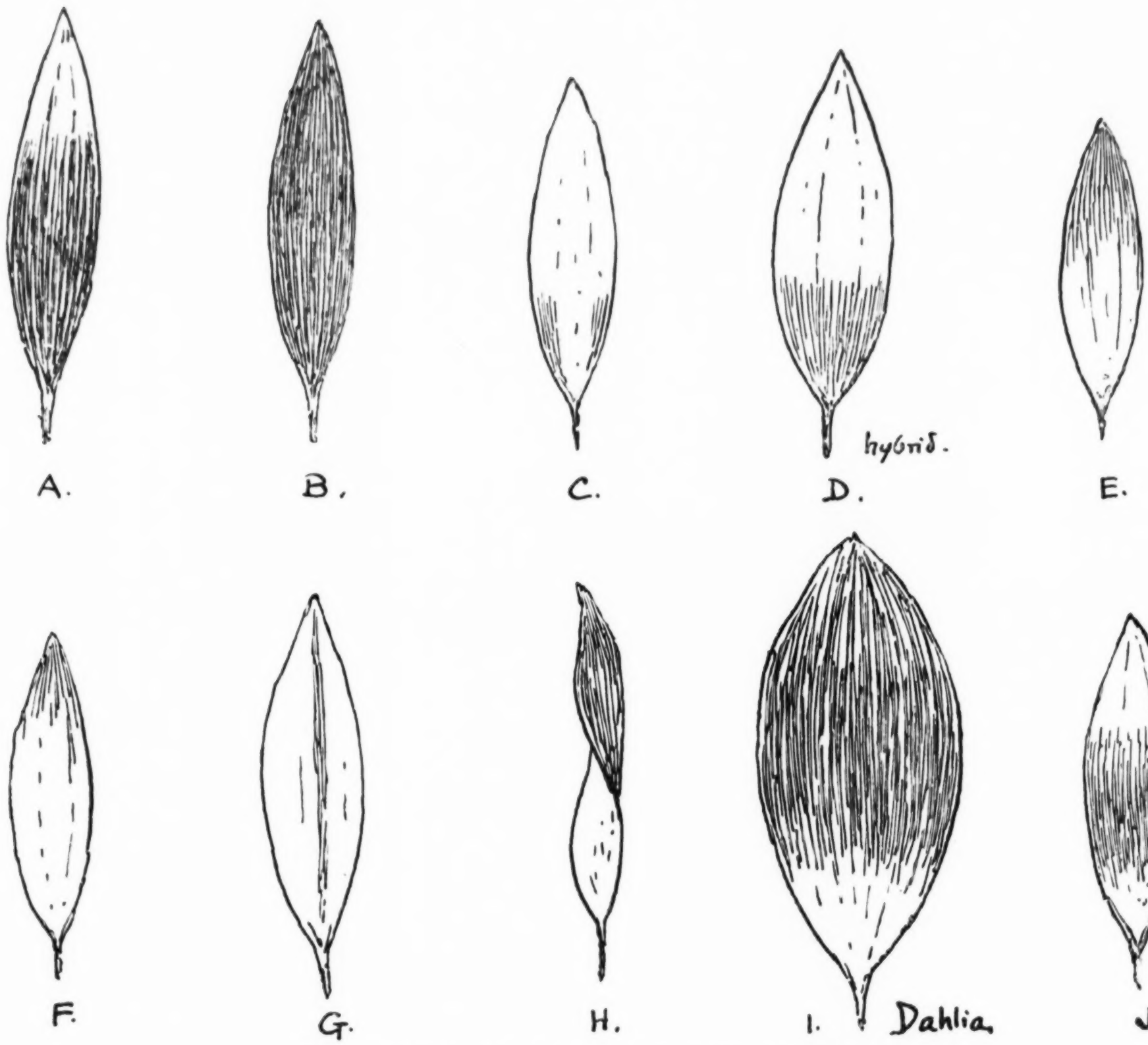
Another class of hidden characters has to do with the markings of those varieties which assume a red color. In the ordinary orange-rayed sunflowers it is often possible to detect a certain deepening of the color toward the base of the rays; sometimes this is quite conspicuous. Photographs of such flowers, taken without a color screen, accentuate this effect, and produce the appearance of strongly bicolored rays. A very remarkable instance of this sort was discovered by G. N. Collins in *Bidens heterophylla*, and published, with good illustrations, in *Plant World*, November, 1900. No species of wild sunflower has red rays, and yet in the red-rayed varieties developed under cultivation, or very rarely found wild as single sports, the distribution of the red is controlled by "marking-factors," which existed prior to and independently of the color-development through which they are made manifest. The independent existence of these marking-factors is shown not only by their behavior in heredity, but also by their partial or faint appearance in the orange (wild) forms, and their revelation through photography.

In the common garden sunflower, *Helianthus annuus*, or rather the series of cultivated forms we have obtained through crossing the original wild red sport (*H. annuus lenticularis* var. *coronatus*) with garden varieties, the marking-factors form a quite definite system. Their independence of the shade of color is shown by the fact that the chestnut-red (*coronatus*) and wine-red (*vinosus*) groups afford exactly parallel series of types. The commonest form (var. *bicolor*) has the basal half or more of the rays dark (chestnut or wine-red) and the apical part yellow or orange in the chestnut forms, primrose-yellow or very pale yellowish in the wine-red. Frequently, however, the base is pale (var. *zonatus*), and the red forms a ring around the head, crossing the middle of the rays. When the pattern-factor is absent, the whole ray is colored, chestnut or wine-red, as the case may be. Such forms frequently show yellow at the extreme base, and sometimes this becomes a definite spot or patch. In an occasional form there are two spots of color, either chestnut or vinous, one on each side of the basal part of the ray; the rest of the ray being orange or pale. (Fig. C). This I call var. *maculatus*. In the vinous or primrose-yellow it is a very pretty thing.

I was ready to suppose that this series of patterns would be found, quite the same, in all annual sunflowers which could be colored red. It turns out, however, that this is not true; that *Helianthus cucumerifolius* has a very different set of patterns. Some years ago M. Herb of Naples sent out what he called *Helianthus cucumerifolius purpureus*, a form with more or less red on the rays. The seeds first distributed produced very unsatisfactory plants, with very little red, and that dingy; but M. Herb persevered, and this year we have some very well-colored varieties raised from seed which he kindly sent. The patterns are on the whole very different from those of *H. annuus*. In the early cultures a common form (illustrated in Herb's catalogue for 1913) had the color confined to about a fourth

A PRODUCT OF SUNFLOWER BREEDING

In 1910, Mrs. Cockerell found near Boulder, Colo., a mutant from the familiar yellow sunflower. Its rays were suffused with chestnut red, which proved on examination to be due to anthocyan, a pink pigment that appeared chestnut because of its background. As there was but one of these mutants, and the sunflower is sterile with its own pollen, it had to be crossed back to the ordinary yellow form; when the seeds of this cross were grown, it was found that about half of the flowers had red rays. One of the forms isolated is shown above, and was named bicolor; in red forms of another species the pattern was reversed, the dark pigment being at the tips instead of the bases of the rays. It is evident from the photograph that there is a pattern factor which controls the distribution of the dark pigment. The presence of this factor would not be suspected in an ordinary yellow sunflower, although it is certainly there. The incident illustrates the fact that one can never know, from mere inspection, all the factors that any plant or animal has inherited, for many of them cannot get expression except under certain rare conditions. (Fig. 5.)



THE WORK OF FACTORS FOR MARKING

A represents the pattern of a ray of *Helianthus annuus*, var. *bicolor*, an entire flower-head of which is shown in Fig. 5. B is the same species, var. ruberrimus (or if the color is vinous, it is called var. vinosissimus); C is a new variety, maculatus, of the same species; D is a hybrid, *H. annuus* var. *coronatus* × *H. cucumerifolius*. E is a ray of the Red Lilliput sunflower of the trade, *H. cucumerifolius*, var. *apicalis;* F is another ray of the same form. G illustrates a new variety, *H. cucumerifolius* var. *vittatus*, and H is the variety purpureus of the same species. I is a dahlia ray and J comes from *Helianthus annuus* var. *zonatus*. (Fig. 6.)

of the ray, at the extreme base. A very pretty variety has the *ends* of the rays (half or less) delicately reddened, thus reversing the condition in *H. annuus* var. *bicolor*. It is this variety which was offered by Peter Henderson & Co. in their catalogue for 1915, under the name of Red Lilliput, with a rather over-colored but otherwise very characteristic figure. A more singular form, occurring in this year's cultures from Herb's seeds, has a variably distinct narrow red stripe down the middle of the ray (Fig. G); this occurs both on a sulphur yellow and a pale primrose background. Finally, we have obtained a plant in which the whole upper surface of the rays is a deep brownish-pink or dull crimson, while the under side is clear light sulphur yellow, in complete contrast (Fig. H). The contrast between the upper and lower sides is emphasised by the twisting of the rays.

All these plants from M. Herb's seeds are *H. cucumerifolius*, not hybrids with *H. annuus coronatus*, as is shown by the bracts. They have developed their red color quite independently of our *coronatus*.

We have raised a number of hybrids between our red *H. annuus* forms and the various forms of *H. cucumerifolius*.

These hybrids show the chestnut red color on the basal part of the rays, usually covering less than half of the ray (Fig. D). The general effect is quite different from that of *H. annuus* var. *bicolor*. A full description of one of the best of these hybrids is given in *Standard Cyclop. Horticulture*, Vol. III, page 1446.

This year we have obtained a very interesting hybrid, which may be called × *evanescens*. It is derived from a vinous *H. annuus* (v. *vinosus*) × a very pale *H. cucumerifolius*. The red color, therefore, comes from the *annuus* side. The disc is dark, and the rays vary from clear bright lemon (not orange) to pale primrose. When the flowers first open, the basal third or more of the rays is suffused with the anthocyan color, which in the lemon rays is a clear chestnut, often very bright and conspicuous. With time, this red color fades out completely, leaving in its place an orange suffusion. The appearance of the lemon-rayed variety from primrose or cream ancestry appears to confirm the suggestion made in a footnote in *Science*, August 21, 1914, to the effect that "the pigment of the primrose variety is quite the same as that of the lemon one, appearing paler only because not massed." The factor for *density* of pigment is apparently independent of that which controls the *kind* of pigment. The loss of the red color with maturity can be understood on the supposition that a deoxidising factor or substance (as described by Miss Wheldale) develops.

In the dahlia we find another series of color patterns, more or less like those of the sunflower, and similarly independent of the kind of color, whether scarlet or yellow, or vinous or white (compare the colored plates in *Gardeners' Chronicle*, March 14 and May 23, 1914). I figure, for comparison, a dahlia ray (Fig. I) in which the basal third or less is light yellow, and the rest vinous, reversing the condition of the *Helianthus cucumerifolius* × *annuus* hybrid.

Thus it appears that plants may contain determiners, or whatever we please to call them, which produce practically no visible effect in the normal forms, but which give rise to a complex series of effects as soon as anthocyan pigments appear in the rays. We are warned by such phenomena as these that our breeding experiments cannot always (? ever) be really restricted to a chosen set of characters; that other characters lie in wait, as it were, to confuse us and trip us up. In other words, the internal environment of the character studied cannot long be neglected, difficult as it may be to understand or to control.

Inheritance of Sex in Strawberries

Many thousand strawberry seedlings have been grown at the New York (Geneva) Experiment Station, including some 3,000 selfed plants which have come mainly from five parents. The problem with this fruit of chief importance to the plant breeder is the inheritance of sex.

While the main breeding work at this station is with fruit, yet the isolation of pure lines in varieties of peas, beans, cabbage and potatoes is also being carried on.

For nearly twenty years the general problem of the improvement of plants through bud-selection has been in hand. Originally this work was started with the Rome Beauty apple. It now includes also the Baldwin apple. In order to get results more quickly and to handle a larger number of individuals this problem is now being studied in the greenhouses by means of the English violet.

NATURAL SELECTION IN WAR

Conclusions as to Eugenic Results of Conflict Cannot Be Drawn Without Inquiry As to Very Large Number of Different Factors—War May Either Help or Hinder Race Betterment—Present Strife is Overwhelmingly Dysgenic in Effect

ROSWELL H. JOHNSON
University of Pittsburgh, Pittsburgh, Pa.

THE unqualified statement that war is either eugenic or dysgenic in its effect on the human race, is found, on closer investigation to be unjustifiable. The modification of selection by war is far more manifold than the literature on the biological effects of war would lead the reader to suppose. All wars are partly eugenic and partly dysgenic. Some are mainly eugenic and others mainly dysgenic.

Natural selection should be subdivided into (1) lethal, that which operates through differential mortality; (2) sexual, that which operates through differential mating; and (3) fecundal, that which operates through differential fecundity. Again, selection operates both in an inter-group competition and an intra-group competition. We must, then, in analyzing the influence of any agency on natural selection, examine it under each of these six heads. In the case of war, however, we may eliminate fecundal selection, as it is little influenced. Still another division arises from the fact that the action of selection is different during a war upon the armed forces themselves and upon the population at home; and after the war, upon the nations with the various modifications that the war has left.

We will consider lethal selection first. To measure the effect of the inter-group selection of the armed forces, we have to compare the relative quality of the two races involved. The evidence for believing in substantial differences between races is based (*a*) upon their relative achievement when each is isolated, (*b*) upon the relative rank when the two are competing in one society, and (*c*) upon the relative number of original contributions to civilization each has made. Such comparisons lead us to reject the sentimental equalitarianism that denies race differences. While we admit of course a great deal of overlapping, there are, nevertheless, real average differences. To think otherwise is to discard evolution and revert to the older standpoint of "special creation."

The comparison of the quality of the two sides becomes more and more difficult as fighting is more and more between groups of allies which may differ greatly among themselves. Yet this by no means removes the inequality of the two sides taken each as a whole.

Without entering into the evidence at this time, we readily see that the eugenic effect of war would be very different according as the sides differ much or little. Yet this difference in quality, however great, will have no significance, unless the superior or inferior side is in general more likely to lose fewer men. Where the difference has been considerable, as between a civilized and savage nation, it has been seldom that the superior does not triumph with fewer losses. Victory, however, is influenced much less in these later days by the relative military efficiency of two single nations than by the success in making alliances with powerful nations. But such alignments are by no means always associated with better quality, because (*a*) there is a natural tendency for the weak to unite against a strong nation, (*b*) to side with a group which is apparently succeeding, and (*c*) the alliances may be the work

of one or a few individuals who happen to be in positions of power at the critical time.

HIGH QUALITY ON BOTH SIDES

In this present war the contrast is particularly noticeable, since on both sides the combatants are in so large a proportion members of the old Teutonic or Hebrew races, both stocks being preëminent for their contributions to science and art. In this very feature, it is probable that we have the most noteworthy dysgenic element in the present war.

As for the selection taking place within each of the struggling nations, we must consider first of all the contrast between the combatants and the non-combatants of the same age and sex. This difference depends largely on how the army in question was raised. Where the army is a permanent, paid force, it probably does not represent a quality above the average of the nation, except physically. When it is conscripted, it will be superior physically, and probably slightly in other respects. If it is a volunteer army, its quality will depend largely on whether the cause being fought for is one that appeals to adventurers merely or one that appeals to some moral principle. In the latter case, the quality may be such that the loss of a large part of the army will be peculiarly damaging. This situation is more common than might be supposed, for by skillful diplomacy and journalism, a cause which may be really questionable, is presented to the public in a most idealistic light. In the present war, the soldiers of each country have been made to believe that *they* are the glorious defenders against unprincipled aggressors.

Even within the army of one side, lethal selection is operative. Those who are killed are by no means a haphazard sample of the whole army. Among the victims there is a disproportionate representation of those with (1) dauntless bravery, (2) recklessness, (3) stupidity. These qualities merge into each other, yet in their extremes they are widely different. However, as the nature of warfare changes, with the increase of artillery, mines and bombs, and decrease of personal combat, those who fall are more and more chance victims.

In addition to the killed and mortally wounded, there are many deaths from disease or from wounds which are not necessarily fatal. Probably the most selective of any of these three agencies is the variable resistance to disease and the widely varying knowledge and appreciation of the need for hygienic living shown by the individual, as, for instance, less reckless drinking of unsterilized water. But here, too, in modern warfare, this item is becoming less selective, with the advance in discipline and in organized sanitation.

The efficiency of selection will be affected by the percentage that each side has sent to the front, if the combatants are either above or below the average of the population. A nation that sends all its able-bodied males forward will be affected differently from its enemy that has needed to call upon only one-half of its able-bodied men in order to win its cause.

THE POPULATION AT HOME

Back from the fighting lines of the contending sides, the conditions that prevail are rendered more severe in many ways than in times of peace. Poverty becomes rife, and sanitation and medical treatment are commonly sacrificed under the strain. During a war, that mitigation of the action of natural selection, so common now among civilized nations, is somewhat less effective than in times of peace.

After a war has been concluded, certain new agencies of inter-group selection arise. The result depends largely on whether the vanquished have had a superior culture brought to them, as in the case of the Philippines, or whether, on the contrary, certain diseases have been introduced or crushing tribute has been levied, as in the Franco-Prussian War, or grievous oppression such as befell the Hebrews in Egypt.

Sometimes the conquerors themselves have suffered severely as the result of

excessive spoliation, which has produced vicious idleness and luxurious indulgence, with the ultimate effect of diminishing the birth rate.

Within the nation there may be various results. Sometimes, by the reduction of overcrowding, natural selection will be less severe. On the other hand, the loss of that part of the population which is more economically productive is a very serious loss, leading to excessive poverty with increased severity in the action of natural selection. Selection is also rendered more intense by the heavy burden of taxation, as is now so evident in Great Britain directly, and in the very common depreciation of currency as in the Southern States after the Civil War.

Sexual selection as well as lethal is affected by war in manifold ways. Considering the armed force, there is an inter-group selection, when the enemy's women are assaulted by the soldiers. While this has been an important factor in the past, this is less common now, with better army discipline and higher social ideals.

Within the group, mating at the outset of a war is greatly increased by many hurried marriages. There is also sometimes an increase of illegitimacy in the neighborhood of the training camps. In each of these instances, these matings do not represent as much maturity of judgment as there would have been in times of peace, and hence give a less desirable sexual selection.

In considering the belligerent nation at home, the number of marriageable males is of course far less than at ordinary times. It becomes important, then, to compare the quality of the non-combatants and those combatants which survive and return home, since their absence during the war period of course decreases their reproduction as compared with the non-combatants. The marked excess of women over men, both during the war and after, necessarily intensifies the selection of women and proportionately reduces that of men, since relatively fewer men will remain unmated. This excess of women is found in all classes. Among superiors there are, in addition, some women who never marry from the lack of sufficiently eligible suitors caused by the war.

In the past, and still among many savage peoples, inter-group selection has been affected by the stealing of women from the vanquished. The effect of this has been very different, depending on whether these women would otherwise have been killed or spared, and also depending on the relative quality of their nation to that of their conquerors.

To sum up, we find there are so many features of natural selection, each of which must be separately weighed and the whole then balanced, that it is a matter of extensive inquiry to determine whether a certain war has a preponderance of eugenic or dysgenic results. In the present war it would seem that the high quality of both sides compared with the rest of the world is so predominant a dysgenic factor that, together with the other dysgenic features, the eugenic results are overbalanced. The human species therefore on account of this is at present declining in inherent quality faster than in any previous similar length of time.

Pure Lines in Cotton

The influence of environment upon pure lines is being studied in a systematic way by the North Carolina and Mississippi Experiment Stations, which are growing the same strain of cotton in the two localities, and carefully comparing the plants at different stages. The North Carolina Station is further making a study of inheritance and association of some of the important characters of the cotton plant. A study of the value of kernels of corn taken from different portions of the ear has been made and it has been found that those from about the middle produce stalks that yield most heavily.

THE SELF-STERILITY PROBLEM

Many Important Points in Fruit-Growing Still Await Explanation—Recent Progress in the Study—Need of Distinguishing the Various Factors Entering into the Problem[1]

E. J. KRAUS
State Agricultural Experiment Station, Corvallis, Ore.

THE problem of the pollination of horticultural fruits has been, and is, a subject of great practical importance, and of much painstaking investigation. Nevertheless, results from carefully planned and skillfully conducted experiments frequently are so apparently contradictory that when the whole body of facts is considered, very few conclusions seem warranted. In the past far more has been concluded from the work of two, three or even five years than can be justified. The many questions which arise, especially as they relate to the sterility problem, will require, for their solution, years of patient labor. Such solution will not come from a mere dusting of stigmas with pollen in the springtime and an elaborate tabulation of results in the fall.

Still, the outlook is by no means discouraging. Every recorded fact, no matter how seemingly insignificant, is to be regarded as a step in advance even if for the moment it does seem merely to contribute to confusion. While it should be realized that a single fact is more valuable than extended interpretations of opinions based upon hasty observations or limited data, yet it is equally true that hypotheses are often useful and stimulating, and make for advancement in the understanding of facts. It should be remembered that they are hypotheses, and utilized as such; it is when they are regarded as hard and fast conclusions that they become dangerous. The investigator should be willing to discard hypotheses that are clearly shown by facts to be untenable.

The entire question of the causes of self-sterility quite generally in the plant kingdom, and in orchard fruits especially, is largely in the speculative stage. We are just beginning to bring together a great body of facts from which, in time, we confidently may hope to deduce some of the real fundamentals of the self-sterility problem. It should be understood at the outset that some of the statements made in this paper are speculative and consequently should not be regarded as conclusions. While based upon a large amount of experimental data they may be interpreted eventually in some other way.

DEFINITION OF TERMS

First of all, it is necessary that there be a clear understanding of certain terms which often are applied more or less indiscriminately. As used in this paper, a distinction is made between self-fertility, self-fertilization, and self-fruitfulness. The term fertilization is used in a strictly botanical sense; self-fertilization further restricts all gametes concerned to those derived from the same individual. In the case of varieties propagated vegetatively any so-called individual of that variety still would be considered as a mere part of the one individual. Self-fruitful is used to mean the ability of a plant to produce mature fruit, either without pollination (parthenocarpy) or when pollinated with its own pollen, whether or not fertilization takes place, or whether or not seeds are produced. It has reference to the development of vegetative parts only. A fruit tree, therefore, may be self-fruitful and self-sterile, or self-

[1] Read before the twelfth annual meeting of the American Genetic Association, at Berkeley, Cal., August 5, 1915.

CROSS-POLLINATION MAKES NO DIFFERENCE TO THESE APPLES

The Yellow Newtown apple, here photographed, is a self-fertile variety. At the left are three specimens which were produced as the result of cross-pollination; the specimens at the right arose from self-pollination. It is obvious that there is no gain in appearance from the cross-pollination. Growers may consequently feel safe in planting an entire orchard to this variety; while such a planting with some varieties that are not self-fertile, would result in very little fruit, because of the lack of opportunity for cross-pollination. Viable seeds are often produced by this variety but the seedlings are weak. (Fig. 7.)

fruitful and self-fertile. Barren and self-barren mean the absolute failure of a tree to produce fruit; the latter term, naturally would imply the lack of application of foreign pollen. The term fertile has been used to express the idea, both of production and capability of production. There is a definite distinction between the two ideas which should be observed, though it would be presumptuous to attempt to settle that question here. Since it seems more in line with usage in other biological sciences to regard fertility as synonymous with the actual production of viable offspring, germinable seeds are considered the true measure of fertility.

Let us consider briefly the term self-fertility. By it is meant the seminal production of independent offspring by an individual when not pollinated or fertilized by another individual. Generally this term has been applied to any plant which produces fruit with its own pollen. As indicated above, however, such an application is far too generalized, since a plant may be self-fertile and yet not be self-fertilized. Examples of such a condition at once come to mind in all cases of apogamy (including parthenogenesis), or vegetative apogamy. Again a plant may be self-fertilized and still not be self-fertile, if fertility is measured by viable seeds. Oftentimes even when actual fertilization has taken place, there is a failure of the embryo either to complete its development, or of the seeds to germinate. For the present discussion, the line which marks the division between the fertility and sterility of an individual is determined, arbitrarily, by whether its seeds do or do not germinate under normally favorable circumstances. This line of demarcation is arbitrary for several reasons; the chief of which is that whether a proembryo or an embryo fails soon after fertilization has taken place, or whether a fully formed embryo actually germinates and the seedling is markedly weak in constitution, the difference in development seems not so much one of kind as of degree. It does seem, however, that one of the definite division lines in the life cycle of a plant is marked by the phenomena of germination of the seed. While a fully matured seed may be called the new individual, throughout the following discussion only the germinated seed is so regarded. Consider in this connection, if you will, the frequent failure to hatch of the eggs of closely inbred domestic fowls, even though the best of incubation conditions have been provided and the eggs contain apparently perfect embryos; and also the premature birth which frequently takes place among animals when species are crossed, or, in common parlance, when the matings are not congenial.

For convenience, self-fertility may be considered to be of two types, first, that directly due to morphological factors, and second, that directly due to physiological factors. Like all classifications, no hard and fast line can be drawn between the two types—they are interdependent to no inconsiderable degree, as will be pointed out later.

MORPHOLOGICAL FACTORS

Morphological factors as causes of self-fertility are, as a rule, the most readily understood because of the relative ease with which they may be studied. Instances are of common occurrence. Beach and Booth have shown that under normal conditions certain self-sterile varieties of grapes are incapable of fertilizing other self-sterile varieties, which "is in many cases, if not all, due to a lack of potency in the pollen." A large proportion, or all, the grains are morphologically imperfect. Dorsey has recently shown that the cause of impotent pollen in the grape is due to "degeneration in the vegetative nucleus," and that in the impotent pollen of certain varieties no germ pore is present.

There is a wide variation in the germinability of apple pollen; it ranges from less than 1% to 100% according to variety. It also should be added that the percentage germination of any variety, even though apparently perfect morphologically, will vary from year to year and is dependent upon many factors such as age and general vitality of the tree, humidity before and during blooming time, soil conditions;

in fact, any environmental factor in the broadest sense of the term. Jeffrey recently has pointed out the widespread occurence of morphologically imperfect pollen in many plants, due, as he says, to the hybrid nature of such plants. Whether the same reasoning can be applied to account for morphologically defective pollen in all fruit varieties is still a question; apparently it accounts for some instances. Morphological imperfection is also of no uncommon occurrence among ovules, as is readily observable on inspecting the ovaries of most double flowers or of many varieties of fruits. There are degrees of imperfection, ranging from merely a lack of proper development of the egg apparatus to an almost complete degeneration of the entire ovule. According to Coit, some normal embryo sacs are produced in occasional fruits of both Washington Navel and Satsuma oranges. If disintegration of the embryo-sacs takes place, it may occur before the formation of the megaspores, but usually not until afterwards. He also states that viable pollen of parthenocarpic varieties is either entirely wanting or is very scarce.

Strictly dioecious forms unless parthenogenetic or apogamous are necessarily self-sterile. In the very interesting cases of total or partial change of the expressed sex of a plant, that is, staminate to pistillate or vice versa, as has been recorded for the Papaya and as has been known to occur to a lesser degree among the willows, sorrel, and some others, there arises a new situation; under the latter circumstances the abnormal individuals actually might be self-fertile.

In the class of morphological adaptations which make for self-sterility, also would fall all those numberless modifications of structure which bring about the prevention of self-pollination. Of course, through the agency of man, dichogamous flowers are capable of being self-pollinated, as they may be also in nature under exceptional circumstances, but as a rule a single flower of either type, when left to itself, would be sterile.

With respect to heterostyled plants, it has been suggested that perhaps the pollen tubes from the short styled flowers were not of sufficient length to penetrate to the eggs of long-styled individuals. It is an interesting suggestion but instances in which this has been investigated would not tend to bear it out. Cases are established in which the pollen tubes do not reach the eggs, but this result, so far as determined, is due to a physiological not a morphological cause.

PHYSIOLOGICAL FACTORS

Passing now to a consideration of what may be termed the physiological causes of sterility, it will be observed that several classes can be made here, too. The first deals with those phenomena classed as chemotactic. This is no doubt a comprehensive grouping, and as more exact data become available, it may be shown that chemotaxis is but a temporarily assigned cause for results not now wholly understood. However, such a classification aids in furnishing a working basis for a consideration of available data.

The greater mass of evidence would indicate that in many instances, it is largely through chemotaxis that the pollen tube is directed in its growth to the embryo sac, and the sperms to the egg. Cases of self sterility which can be explained as having resulted from what may be termed negative chemotaxis are not unknown. To such a cause it seems preferable to ascribe such instances as have been recorded, in which, instead of a progressive increase in the rapidity of the growth of the pollen tube down the style, there is a progressive retardation, and finally total cessation of growth, but neither the conductive nor stigmatic tissues have been destroyed or perceptibly changed.

In his experiments with orchids, Fritz Müller found that not only was the pollen of a given plant, when placed upon its own stigma, prevented from germination, but also that there was a poisonous interaction of pollen and stigma.

To a third class, and so far as orchard fruits are concerned, by all odds the

IN THIS CASE CROSS-POLLINATION IS OF SOME IMPORTANCE

Under many circumstances the Ben Davis apple, here illustrated, is self-sterile, although it is sometimes self-fertile. The two fruits at the left come from a cross-pollination. At the same time, several hundred blossoms were carefully self-pollinated, and protected from contamination by wind or flying insects. The entire net result of these several hundred self-pollinations is seen in the three fruits at the right. These deformed fruits were infested by aphis or plant lice, a fact which seems to have some bearing on self-fertility, although its meaning is not yet clear. (Fig. 8.)

most important and inclusive, it is difficult to apply a short, descriptive term, though brief discussion will make clear its characteristics. The germination of the pollen grains upon the stigma, the growth of the pollen tube down the style, and generally the union of the proper nuclei within the embryo sac, are apparently normal. Now the interesting fact is, that further developmental phenomena proceed to varying degrees. That is to say, the post-fertilization processes may be normal, with a full and complete development of the endosperm and embryo, or there may be practically no development of the egg after its union with the sperm. All gradations exist between these extremes. Very frequently there is practically a complete development of the endosperm but a far less complete development of the embryo. The changes occurring in the ovule are reflected in the external appearances of the young fruits. Time and again there is an apparent set of fruit when blossoms are self-fertilized, but within a period of several days or weeks the young fruit turns yellow and finally drops. On cutting into such fruits to examine the seeds, a highly interesting situation is disclosed. If the fruit has fallen while still very small, it will be noted that there has been very slight development of the ovules, though there is evidence that the endosperm has begun development and often the embryo also, but only to a very slight degree. Fruits which have remained on the tree for a greater length of time generally show a much greater degree of development of endosperm and usually, though by no means always, a greater development of the embryo. Fruits which have fallen when half grown generally show what appears to have been a complete development of endosperm and the embryo clearly visible to the unaided eye, often filling half and sometimes a much greater proportion of the seed. It is interesting to note that in most self-sterile, but not self-fruitful or parthenocarpic, varieties of apples and pears, the extent of development of the embryo can be predicted with a high degree of accuracy from the observation of the size or weight of the fruit; the larger the fruit the greater the embryo development. This is in accord with the fact already well known that, under like conditions in varieties of apples and pears which are not parthenocarpic, there is generally an important correlation between weight of seed and weight of fruit. One more condition should be mentioned. In mature fruits, shrivelled seeds, which were apparently of full size before the shrivelling took place, are of common occurrence. Examination of such seeds discloses an entire lack of embryo or one exceedingly small and aborted. Earlier inspection shows the seed-coats filled with endosperm, which shrinks away on maturity of the fruit.

FAILURE OF EMBRYOS

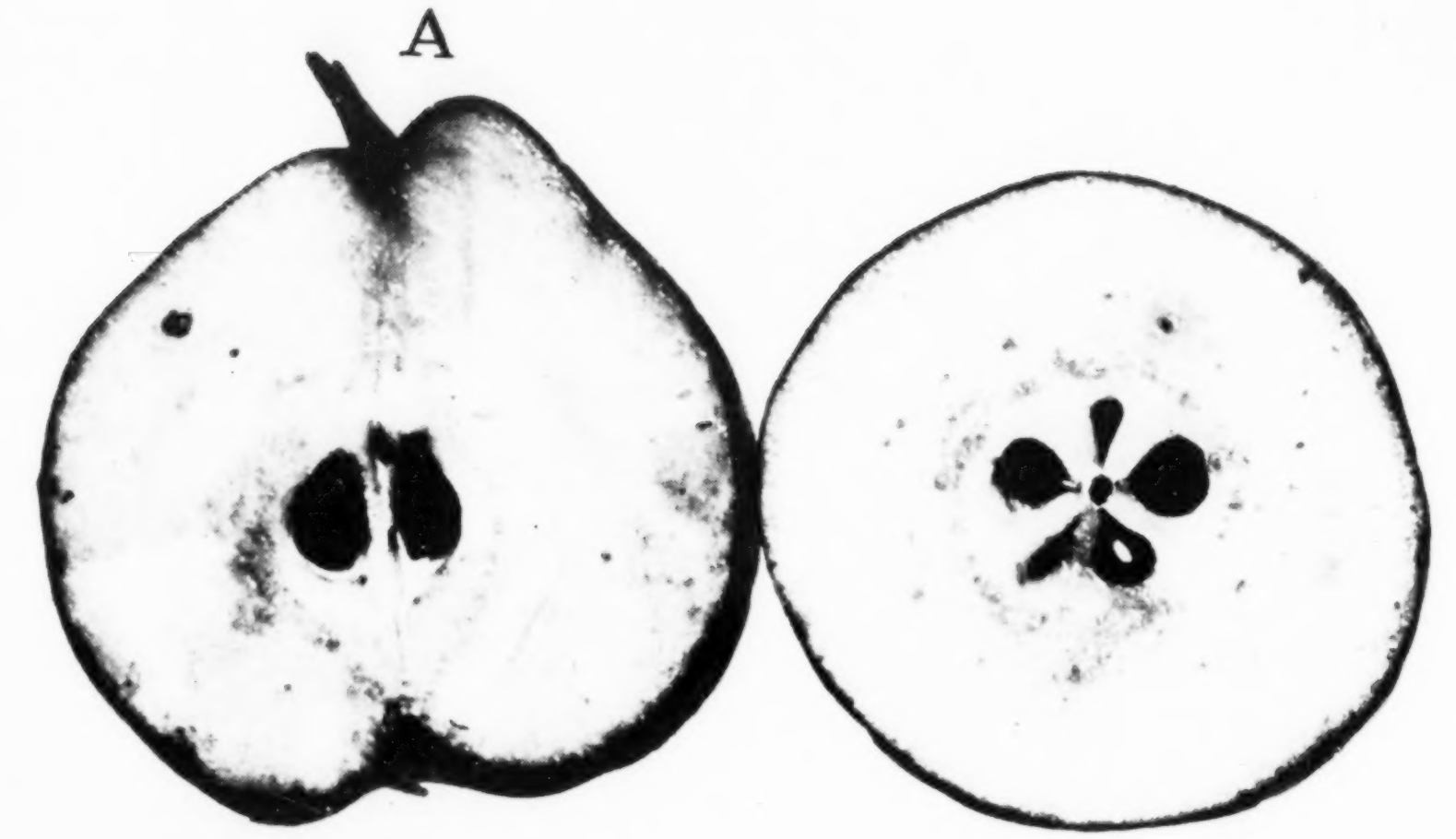
How to account for the failure of the embryos at various stages in their development is not entirely clear, but in a study of this problem, some interesting phases have arisen. In reference to pollination of orchard fruits, several records are available which state that the variety is self-sterile except for a few misshapen or small fruits harvested from clusters infested with aphids. In our own experiments, we have observed this same condition dozens of times. This setting in the presence of aphids has been explained on the grounds that the aphids, in crawling over the blossoms, carried the pollen on to the stigmas, whereas flowers simply inclosed in sacks were not so thoroughly pollinated. The view hardly seems tenable because, unless very hard pressed for time, even when flower clusters are tagged for self-fertility tests, we brush over the stigmas of the flowers with their own pollen; and the most frequently occurring condition of this kind with us is that due to the rosy apple aphis which works on the leaves in the cluster, badly deforming them, but, in most circumstances, does not come into contact with the fruit at all, though the latter is deformed also. In the case of apple varieties which normally are neither self-fertile nor self-fruitful, in other words self-barren, not only is it possible to cause the fruit to set if

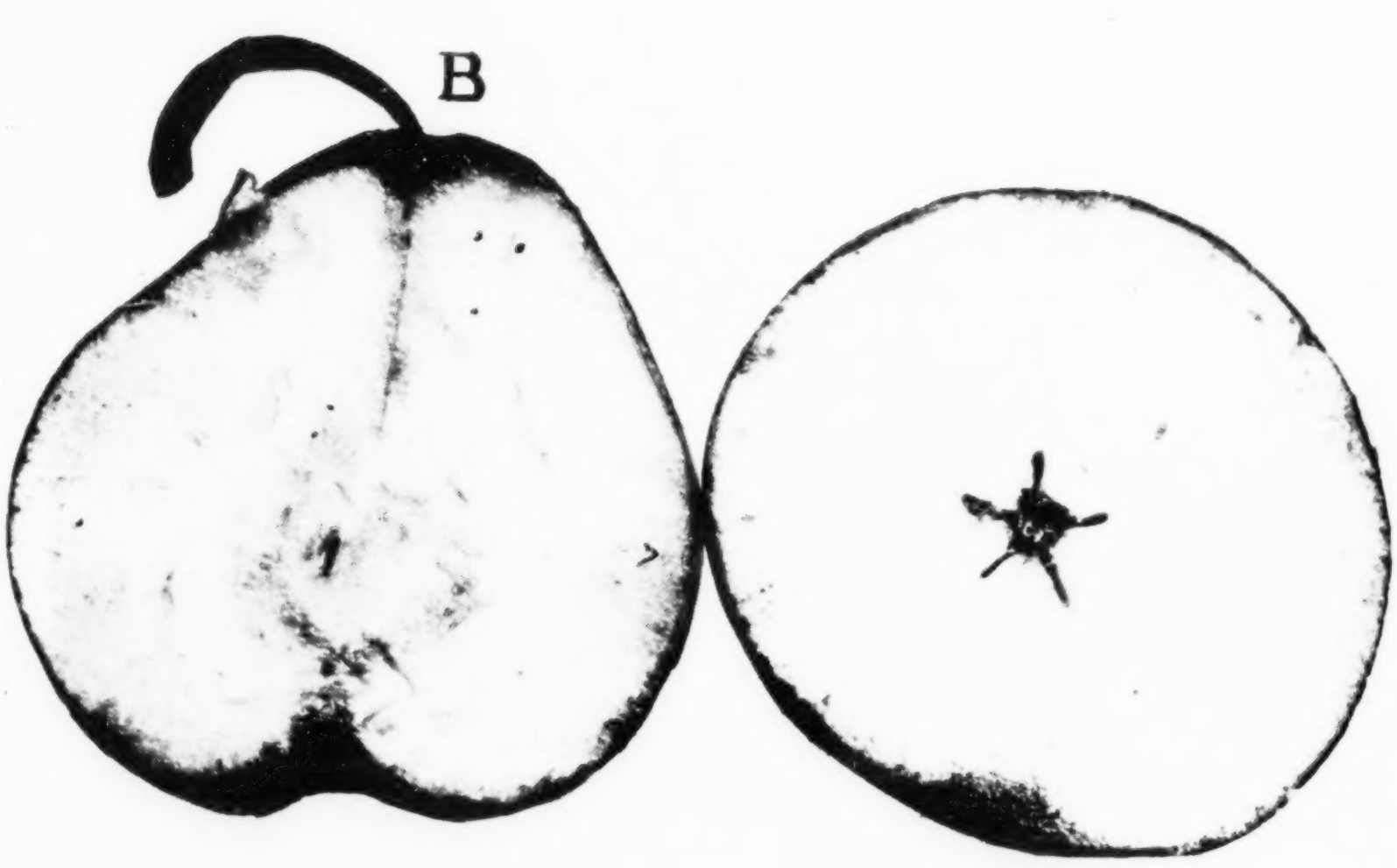
aphids are present at blooming time, but it is actually possible to produce embryo-containing seeds, none of which have we ever succeeded in germinating. Accidentally and intentionally this result has been obtained many times. Of course, such fruits are usually deformed: the longer and more severe the infestation, the greater the deformity. Gardner has found in cherries a similar condition, produced by the black cherry aphis. None of the pits, however, matured embryos. There is a radical change in the vascular system of fruits badly deformed through aphis infestation and such fruits may remain hanging on the trees for several years. The greatest change, however, is that the embryo resulting from self-fertilization at times will complete its development under such circumstances and absolutely fails under normal conditions. It would seem that this peculiar behavior of aphis infested fruits has a fundamental significance, especially when considered in connection with a study of vegetative parts.

It was soon realized that to arrive anywhere in a study of this problem it would be necessary to begin such a study very early in the history of the flower. In our own work on the apple and pear, we have not only examined the fruit bud in its very beginning, but also the vascular anatomy of the spur or branch from which it arose. Why this latter seemed important will become evident directly. It has been demonstrated that morphologically defective pollen is present in many varieties of orchard fruits at the time the anthers open. At once the question arises, at what stage of development of the blossom does the abnormality of development occur, and what is the nature of such abnormality? Recent investigations have given one answer to the problem. The same question may well be asked regarding any abnormality of ovules. When there appears to be no particular abnormality of either pollen or ovules, one naturally seeks to discover other causes.

To observe that apparently there is a normal union of sperm and egg cells and nuclei, and then a varying development of endosperm and embryo from little more than none to complete, demands further search for the causes underlying such behavior. Anyone who has carried on pollination experiments knows full well that the application of so-called acceptable pollen does not necessarily insure fertility. To a lesser degree, the phenomena above enumerated under self-fertilization take place after cross-fertilization, and this is true even though pollen of the highest germinability be used.

Such a result leads one to look beyond the pollen and egg cells, important though they may be, and he is naturally led to question whether there is not something to be gained from a study of the nutritive processes of structures concerned in seed formation and development. Are there abnormalities of somatic tissue which actually preclude seed and fruit formation even though the eggs and sperms immediately concerned are not lacking in their essential qualities? Often the high percentages of apparent set from self-pollination or cross-pollination shrink to a discouraging zero before the maturity of the fruit. How often, too, a fair sized fruit is found to be without "plump" seeds. The careful observer has noticed that this latter occurrence is comparatively frequent among certain varieties and extremely rare among others. Is there a reason for this? What is the cause for certain varieties being able to produce seedless fruits when self-pollinated, while others absolutely fail to mature fruit unless good seeds are present? Or why will many fruits develop parthenocarpically? As more cases are investigated, the evidence of differences in texture and even chemical composition of seed bearing and seedless fruits, is increasing rapidly. Perhaps all are familiar with the differences in flavor and texture of seedless and seed bearing grapes in the same cluster. Hume has pointed out the differences in persimmons. English cucumbers are "often rendered unfit for use when they bear seeds." The quality and texture of apples and pears are distinctly different when the fruits have developed parthenocarpically. To me all this





THE PRODUCTION OF SEEDLESS PEARS

This is the Winter Nelis pear, a self-fruitful and, very rarely, self-fertile variety. Above is a fruit produced by cross-pollination, and having the full complement of seeds. Below is a fruit produced from self-pollination—it is entirely normal both size and shape, but has not a single seed. It has been determined that parthenocarpy—the production of fruits without seeds—occurs only rarely in this variety. (Fig. 9.)

points to a phase of the pollination and fertility investigations that have not received the attention they merit; namely, a thorough study of the vascular system of fruits. There certainly are varying degrees of interdependence of seed and flesh formation. This absolute dependence of some varieties upon the presence of seeds in order to reach maturity and the absolute independence of others raises a series of questions which as yet are not understood but deserve careful attention. Of course, they may have a more direct bearing in the problems of self-fruitfulness and parthenocarpy, but they are by no means to be disregarded in solving the problem of self-sterility.

STUDY OF THE CELL

The further study of the phenomena of gametogenesis and fertilization, especially as related to nutrition, is absolutely essential. Coulter's recent contribution on reproduction in plants, especially that portion which deals with the conditions under which gametes are formed, is most suggestive in this latter regard. Much more information is needed on nutrition and its relation to embryo development, and the interrelation of vegetative or somatic vigor to reproductive vigor. Cannot the one be measured in terms of the other to a considerable degree? The possibility of changing certain varieties from a self-sterile condition to a so-called self-fertile one by a change in nutrition is too well known to require more than mention, but the fact should not be overlooked that in the great majority of such cases actual self-fertility has not been induced but rather a condition of self-fruitfulness. In many varieties of apples, it is possible to bring about self-fruitfulness (without plump seeds) by a change in nutrition *and* self-pollination; it is much more difficult to do so when no pollination takes place. It seems that a stimulation of the ovules must be induced, and this stimulation transmitted to the vascular system; and that when a "tendency to develop" has been set up, the fruit continues to develop whether seeds are present or not. A greater expression of this "tendency to develop" is evident when fruit is produced without pollination, but some other abnormal condition of nutrition or stimulation has been applied to bring about the result. Its greatest expression is the production of fruit, normally parthenocarpic; a phenomenon purely vegetative in character, neither pollination nor abnormal stimulation having been required. It may be argued that the term "tendency to develop" explains nothing. Granted; however, it expresses an existing condition or relation, the fuller explanation of which will come from a more thorough study of vegetative parts, and a correlation of their structure and developmental behavior with fertilization and seed production, whether such correlation be positive or negative.

Home-grown or Foreign Seed

At the Maine Agricultural Experiment Station studies on inheritance in oats and beans, having regard to yield, color, and other characters, have been under way for some years; cross-bred apples are being studied, and the effect of selection in populations and pure lines is also the subject of investigation. In view of the importance of the oat crop in the state, that cereal has been given special attention, with the view of securing the best possible varieties for local conditions. The work was begun by a careful test of the varieties already in use, and continued by isolation of pure lines and by hybridization. The current idea among farmers that foreign-grown seed is better than home grown, has been found here, as elsewhere, to have little basis; frequently, indeed, a variety behaves much better after it has been acclimatized for a year or two.

PLANT BREEDING IN CUBA

Rich Opportunities for Geneticists—Attempts Made to Utilize Natural Resources—Interesting Problems of the Mango and Other Fruits

F. S. EARLE, *Herradura, Cuba*, and WILSON POPENOE,
Bureau of Plant Industry, Washington, D. C.

A DISCUSSION of plant breeding in Cuba must necessarily deal more with opportunities than with accomplishments, since it is only in very recent years that any attention has been devoted to this subject, and the work is still in its infancy. Along several of the most important lines, however, a good start has been made, and with the remarkably rich field which Cuba possesses it is scarcely conceivable that the near future will not see some noteworthy advances in the development of new and superior forms of cane, tobacco, maize, vegetables and tropical fruits.

Naturally enough, when the improvement of Cuban crops was first taken up eleven years ago, when the senior author was called to the island to organize the Government Experiment Station, the most important cultures were the first ones to receive attention. The testing of seedling sugar canes has been carried on for the past ten or twelve years at the Harvard Experiment Station, which is maintained by Mr. Atkins, president of the American Sugar Refining Co., at his Soledad plantation near Cienfuegos. As is well known, sugar cane is usually propagated by planting the stalks; seedlings were first successfully grown by the British in Barbados and Demerara, but recently they have been propagated throughout the tropical world in great numbers, in the hope of obtaining varieties which would be more resistant to certain diseases or contain a greater amount of sugar. At Soledad the special problem has been to find varieties so well adapted to local conditions that the yield can be maintained in the face of lessened soil fertility due to long-continued planting to this one crop.

The soils of the Soledad district are peculiar in not responding to the use of commercial fertilizers. Other Cuban soils, especially the red lands and the sandy loams, give excellent results when fertilizers are applied to them, and their productiveness can be maintained without difficulty. Since sugar cane occupies the land continuously for a number of years the soil cannot readily be improved through crop rotation or green cover crops. Stable manure is out of the question, hence when commercial fertilizers fail to give the desired results the problem is a serious one. What possible solution could be found for such an unusual problem—to make a plant continue to yield heavily while the soil in which it grows is being steadily exhausted? Few investigators would have thought of genetics as a solution; but the attempt to get around the situation through scientific plant breeding was made and is proving successful, since many of the seedlings are giving satisfactory yields even on thin and exhausted soils.

DISEASE RESISTANCE

In addition to the production of seedling canes which will maintain a profitable yield on poor soils, an effort has been made, in a very limited way, to obtain through selection strains which will be resistant to the root rot, a disease supposed to be caused by *Marasmius sacchari*. On virgin timber lands in Cuba cane will often continue to give profitable results for twenty or twenty-five years without replanting. At length, with soil exhaustion and the increase of disease due to continuous cultivation of this one crop, the fields die out and must be replanted every third or fourth year. The cane usually

A CUBAN FRUIT OF PROMISE

One of the things needed by tropical fruit growers is a satisfactory grape. Most of the grapes known to commerce are natives of temperate countries, and have never given satisfactory results in warm regions; hence good grapes are not now grown in tropical America. In the wild Caribbean grape here illustrated, however, is a plant which breeders can probably make serve their needs. It is found in many parts of Cuba and the West Indies, and even in a wild form its berries are as good as those of some of the North American wild grapes, which have been so admirably improved during the last century. There is reason to believe that the plant breeders can produce from this stock a grape that will meet their wants as well as the Concord and other varieties meet those of North America. (Fig. 10).

begins to die at certain spots in the field where growth is weakest, and the disease spreads in concentric circles until there are bare spots of an acre or more. Always, however, occasional stools survive in these diseased areas, and continued observation of this fact led to the conclusion that some of these stools represented plants which had greater resistance to the disease than the average. It is well known that varieties differ very noticeably in their resistence to the disease, and if particularly immune strains exist in the widely planted Cristalina cane, which is so satisfactory in Cuba from most other points of view, the fact is of the greatest importance. At one time this problem was taken up by the Cuban-American Sugar Co., and many strains were selected for trial. Unfortunately, the work was dropped before any results were obtained, but the question is one which promises to yield most valuable results when the necessary attention is given it.

While cane and tobacco[1] naturally occupy the most important places in Cuban agricultural investigations, to the plant breeder there is probably no field of greater interest than the improvement of tropical fruits. Cuba possesses unusually good opportunities for this work, due to the wide variety of fruits which are found in the island, and the great abundance of several of them, such as, for example, the avocado[2] and the mango.

The northerner coming to Cuba is apt to scoff at many of the native fruits, and to compare them unfavorably with the temperate fruits to which he has been accustomed. In doing so, he fails to remember that most of the tropical fruits—practically all with the exception of the pineapple and the banana—are nothing more than half-wild seedlings. In the majority of cases, even an occasional superior variety which may originate through seedling variation is lost because of the fact that vegetative propagation has never been generally understood or applied in the tropics. It is no wonder, then, that many of the tropical fruits, in their present state, are of rather inferior quality. On the contrary, it is doubtful if the wild prototypes of many of our cultivated temperate fruits are so attractive or so palatable as many of these tropical species which are in the same state of nature.

SELECTION OF FRUITS

The most obvious means of improving most of the tropical fruits, and the one which offers the most immediate results, is selection. With the great number of seedlings which are found in Cuba, it is not difficult to find occasional ones which are much superior to the average and worthy of propagation. We are just now getting to the point where we can bud or graft most tropical fruit trees, and hence the work of improvement is just being commenced. It can scarcely be said that Cuba is behind in this work, though more has been done in Florida in regard to working out methods of propagation which will permit choice seedlings of mangos, avocados and other fruits to be perpetuated. Efforts at hybridization have been few or practically none, yet in several respects this field, too, offers remarkably good opportunities.

The tropics have long been in need of a grape which would flourish and produce abundantly, the Malaga type (*Vitis vinifera*) as well as the North American varieties having proved to be poorly adapted to tropical conditions, though the South European grapes are occasionally grown in Cuba and other tropical countries with a certain degree of success. There exists in Cuba,

---

[1] A short paper on selected strains of tobacco was published by Dr. Heinrich Hasselbring as the result of his work at the Estación Experimental Agronomica. This is the only paper dealing with plant breeding that has yet been issued by the station, whose work was largely suspended for a number of years, because of political conditions, and has only recently been resumed with vigor.

[2] The avocado (*Persea gratissima* Gaertner, a member of the laurel family) is known in tropical America as aguacate, a name based on the Aztec name ahuacatl. Avocado is a corruption of this name, which seems to have become firmly established in the United States. The term "alligator pear" is also used in this country, but is misleading and objectionable.

THE CUBAN WALNUT

Good nuts are comparatively scarce in the tropics, and Cuban plant breeders have, therefore, a great opportunity in the possession of this wild species of walnut. It compares favorably in size of nuts with the North American black walnut, and should easily yield to selection and hybridization, as well as furnishing a stock on which to graft temperate varieties. Photograph from H. A. Van Hermann. (Fig. 11.)

however, a native species, *Vitis caribæa*, which might, through hybridization with some of the cultivated grapes, give rise to a race which would be of the greatest value to tropical regions. The vigor and productiveness of this wild grape suggest that it might also be of value as a stock on which to graft varieties of the vinifera type. Even in its present form this grape is equal, in size and quality, to many of the wild grapes of North America; the individual berries are about 3/8 of an inch in diameter, dark purple, juicy, and produced in good sized clusters. The plant is a strong climber, sometimes covering trees 18 or 20 feet high. At Santiago de las Vegas it has been cultivated on trellises and has done remarkably well. Two distinct forms have been noted in different parts of Cuba, one with a close, compact fruit cluster, the other producing looser clusters and fewer berries.

Another native plant of possible economic value has recently been brought to the attention of horticulturists by H. A. Van Hermann and Dr. Juan T. Roig. This is the Cuban walnut, *Juglans insularis*, a tree occurring in the mountains of the island and producing nuts which compare favorably in size with the northern black walnut. The kernels are difficult to remove from the shell, however, and the partitions are thick. The tree is not at all common, and horticulturally speaking it is practically unknown, yet it might be of great value as a stock on which to graft some of the cultivated walnuts, or through selection it might be considerably improved. There are very few nuts which succeed in Cuba, or in the tropics generally, and the addition of a walnut to those already cultivated would be a distinct advance. It may be mentioned that the Queensland Nut, *Macadamia ternifolia*, has been fruiting for several years at Santiago de las

Vegas, and gives promise of becoming a valuable thing.

OPPORTUNITIES WITH THE MANGO

In all parts of the island the mango is one of the most abundant of fruits. During July and August it reigns supreme, filling the markets everywhere. Many Cubans prefer the mango to all other fruits, though there are some who would place the pineapple and the anón (*Annona squamosa*) ahead of it, and a few might even consider the sapote or sapodilla (*Achras zapota*) superior. With very few exceptions, however, the varieties or types of mango grown throughout the island are inferior ones, scarcely worthy of propagation, and the opportunity for improvement is great.

Nearly all Cuban mangos are polyembryonic, and reproduce themselves more or less true to type when grown from seed. This peculiarity of certain mangos has been recognized for some time; many years previously, however, when English horticulturists took up the improvement of the mango in India, they found that seedlings from the best varieties were usually much inferior to the parent, and they were forced to depend upon vegetative propagation for the perpetuation of good mangos. The Indian mangos, in many cases at least, are monoembryonic, and seedlings do not come true to type. The West Indian mangos are separable into numerous groups, and it has long been known to the natives that a seed from a mango of any given type would produce a mango of the same type; this reproduction of type is so perfect, indeed, that among twenty or thirty seedlings of one type the fruits will be as similar in every character as the fruits of a grafted variety. The explanation is to be found in the polyembryonic character of the seeds.

Putting the case as simply as possible we may say that the plants which grow from the seed are not derived from a fertilized sexual cell, as is usually the case in the vegetable kingdom, but arise as buds in the tissues which surround the female cell in the ovary. Thus the question of sex does not enter into the origin of these plants any more than it does into the propagation of a geranium by cuttings of the fleshy stem. The mango tree produced in this fashion naturally reproduces the characters of its parent as truly as does a tree propagated by the ordinary means of grafting, since it is a case of vegetative reproduction in both instances.[3]

WELL-DEFINED TYPES

The commonest Cuban mangos are divided into two races, known to the natives as *mango* and *manga;* the former is a tall, erect tree, sometimes 60 feet high, with an oval, open crown, the fruit elongated, laterally compressed, usually curved and beaked at the apex, the fiber surrounding the seed long and coarse. The *manga* race, on the other hand, is a low, spreading tree, 35 or 40 feet high, with a dense, dome-shaped or flat-topped crown, the fruit scarcely compressed laterally and lacking a beak at the apex, the fiber more abundant than in the *mango* race but much finer. Two principal types of the *manga* race are distinguished, *manga amarilla*, an elongated fruit with orange colored flesh, and *manga blanca*, an obliquely spherical form with pale yellow flesh. Both these types are very well defined and one may find trees in various parts of the island which produce fruits absolutely identical in appearance and character. Another race which is less common but very highly esteemed is the Filipino, which is believed to have come from the Philippines by way of Mexico; this is a rather small, erect tree with a dense oval crown, producing elongated, slender fruits, compressed laterally, with very little fiber and of excellent flavor.

Besides these principal races and types, there are to be found, principally at Cienfuegos and in the vicinity of Santiago de Cuba, several less important types, which though very limited in distribution are very superior in quality. The *Chino* and *manga Mamey* of Cienfuegos, and the *Biscochuelo* of Santiago de Cuba, are among the best of these, fruits of all three being shipped to the Habana markets, where they sell at 10 to 25 cents each. These types have originated in certain gardens, where seeds have been brought from other West Indian islands or possibly from the Orient. In most cases they have been propagated locally, and the fruit produced by seedlings of the original tree or trees proves the remarkable constancy of the polyembryonic mangos.

---

[3] John Belling demonstrated that the embryos, which vary in number from two to eight or ten, are derived from the tissue of the endosperm by budding. Whether the ovum itself develops into an embryo or not has never been ascertained; if it does, the effect of cross-fertilization might be shown, and more variation evidenced in the plant from the fertilized ovum than occurs in those plants which arise from adventive embryos.

TREE OF JUGLANS INSULARIS

This wild Cuban walnut is somewhat rare in the mountains of the island, and has only recently been called to the attention of horticulturists by Van Hermann and Roig. (Fig. 12.)

A DELICIOUS FRUIT FROM SOUTH AMERICA

The cherimoya has been called by some writers one of the world's finest fruits. Its rough green skin encloses luscious, melting pulp of custard-like consistency, piquant and delicate in flavor, suggesting pineapples and bananas. While its native home lies within the tropics, it only attains perfection at high altitudes, where the atmosphere is cool and the soil well drained. It has been grown with remarkable success in subtropical regions such as southern California and Madeira, where the conditions of climate and soil approach those of its native home—believed to be the Andes of Peru and Ecuador. The cherimoya (*Annona cherimola*) has been in cultivation for a long time, and numerous varieties have originated. (Fig. 13.)

The most important work in mango improvement yet done in Cuba consists in the selection and propagation of some of these superior seedlings. While the effect of this work is not yet very noticeable, it has served to show what can be done, even by such simple means, and without the aid of budding or grafting. Now that these methods are being applied, however, the opportunities are much greater, and choice monoembryonic varieties can be perpetuated as well as the polyembryonic ones.

THE AVOCADO

The avocado is another favorite of the Cubans, and a fruit which takes a very important place in their dietary during the summer months. It is esteemed by all classes, and forms a substantial part of almost every meal; it is appreciated so highly, in fact, as to have given rise to a common saying, "No puedo comer sin aguacate"—"I cannot eat without avocado."

Everywhere throughout the island the avocado grows abundantly. Naturally enough, the trees are all seedlings, with the exception of the few budded orchards which have recently been planted, and among them there is the greatest variation in size, shape, color and quality of fruit, as well as in productiveness and season of ripening. Unlike the mango, the avocado does not come true from seed, and seeds from an oval green avocado may produce round, oblong or pyriform fruits of green or purple color, smaller or larger than the parent, and varying in other characters as well. For this reason the Cubans do not recognize any different classes of avocados, but call them all *aguacate* without distinction.

From the standpoint of plant breeding, much has already been done in

A FAVORITE CUBAN FRUIT, THE SUGAR-APPLE

While belonging to the same family as the cherimoya, the sugar-apple (*Annona squamosa*) succeeds in strictly tropical regions, and has spread from its native home in America to all parts of the tropical world. It is a favorite fruit in Hindustan, where it has become naturalized and forms dense thickets. In flavor it is sweeter and less piquant than the cherimoya, and there is a much smaller proportion of flesh to seeds. It was crossed with the cherimoya in order to produce a fruit suited to tropical conditions which would have the flavor of the cherimoya and the productiveness of the sugar-apple. (Fig. 14.)

Florida to improve the avocado through selection of seedlings, and Cuba has taken advantage of this by importing budded stock of selected varieties from Florida. In Cuba itself a few selections have been made, yet the field has scarcely been touched, and there can be no doubt but that there are many valuable forms to be found among the Cuban seedlings. The most important point in the selection of varieties at the present time is lateness of ripening, since it is the late fruits which bring the highest prices when shipped to northern markets. Here and there throughout the island are found occasional seedling trees which hold their fruit until December, January or even February. These should be hunted out and propagated.

THE CUSTARD-APPLES

Other Cuban fruits which undoubtedly possess great possibilities in the hands of the intelligent horticulturist, first through vegetative propagation of the best existing seedlings, then through further improvement by selection and hybridization, are the annonas, especially the anón (*Annona squamosa*), known in English as sugar-apple, and the guanábana or sour-sop (*A. muricata*). Hybrids between the sugar-apple and the cherimoya (*A. cherimola*) made by Edward Simmonds in Florida have demonstrated the possibilities along this line. The cherimoya, without doubt the finest flavored of the cultivated annonas, does not attain perfection in a truly tropical climate. The sugar-apple, on the other hand, is perfectly at home and fruits abundantly. The hybrid between these two species is a plant with foliage remarkably similar to that of the cherimoya, and with fruits a little larger than the average sugar-apple, with the carpellary divisions less deeply incised, and with a more pleasant, slightly acidulous flavor, almost midway between that of the cherimoya and the sugar-apple. It fruits somewhat more abundantly than the cherimoya but less so than the sugar-apple. Crosses should be made in Cuba between these species as well as between the sour-sop and the cherimoya.

Previous to the American intervention, citrous fruits were grown in Cuba almost exclusively from seed. Valuable seedling types, particularly of oranges, are often encountered growing half wild in neglected gardens and fence rows. In the early days of the Estación Experimental Agronomica (the Government Experiment Station at Santiago de las Vegas) the work of searching out and propagating these desirable seedlings was commenced, but was not carried very far. Undoubtedly when completed it will yield some valuable results in the way of varieties adapted to Cuban conditions. Other fruits, such as the caimito or star-apple (*Chrysophyllum cainito*) the sapote or sapodilla (*Achras zapota*), the mamey Santo Domingo (*Mammea americana*), the mamey colorado (*Lucuma mammosa*), and the common guava (*Psidium guajava*), all of importance in the economy of the Cuban people, will doubtless come in for their share of attention in later years.

IMPORTANT VEGETABLES

Many of the more important tropical vegetables, such as sweet potatoes and yams, malanga (*Colocasia* sp.) and yuca (*Manihot utilissima*), all of which are widely grown in Cuba, are propagated asexually. The opportunity for selection is not lacking, however, since bud variation seems to be much more common in the tropics than in temperate regions. Existing varieties of these crops are usually very local in distribution and few attempts have been made to determine which are the most valuable and best adapted to different conditions. In sweet potatoes, an important piece of work has recently been undertaken by Dr. Juan T. Roig of the Estación Experimental Agronomica, who has assembled a collection of varieties, over eighty in all, from different parts of the island, and is now determining the comparative value of each.

Northern vegetables of many kinds are successfully grown in Cuba during the winter months. Certain varieties

HYBRID BETWEEN CHERIMOYA AND SUGAR-APPLE

In this interesting hybrid, which was the result of pollinating the stigmas of the cherimoya with pollen of the sugar-apple, one can see several characters of each parent. The leaves are broad, resembling those of the cherimoya, but smooth like those of the sugar-apple. The protuberances are more distinct than in the cherimoya, but less deeply incised than in the sugar-apple, while the seeds are somewhat distinct from those of either species, larger than those of the sugar-apple and darker colored than those of the cherimoya. The flavor is about midway between the two species. The tree fruits more freely in Florida than the cherimoya, and seems much better adapted to strictly tropical conditions. This represents one of the first efforts along a line of plant breeding which holds great promise for all tropical countries. (Fig. 15.)

of each kind have been found to succeed better than others, but no systematic effort has been made to determine which are the most desirable ones from all points of view, nor to develop new ones in those cases where none of the introduced varieties is satisfactory.

Maize, or Indian corn, is another crop that presents great opportunities for selection and improvement. During the early years of the Estación Experimental Agronomica a great number of varieties from all parts of the United States and Mexico were tested, but none proved to be well adapted to Cuban conditions. The common variety cultivated in the island was originally of a yellow flint type; the ears are unusually heavily protected with husks which completely close at the tip, and the husks, leaves and stalks are abundantly covered with a thick white

tomentum. This seems to protect the young leaves while still inrolled in the apex of the growing stalk from the attacks of numerous small insects, which are always seen working about them. It is apparently the attacks of these insects that prevent the successful cultivation of smooth leaved northern types of corn in Cuba. The heavy husks, which serve to protect the ears from the attacks of the corn weevil, are doubtless the result of unconscious selection, since under the conditions which exist in Cuba only the ears which are so protected can be successfully kept from the time they are harvested until the next planting season. Large quantities of dent corn are annually imported into Cuba from the United States and from Argentina. Some of this has occasionally been planted and has developed sufficiently to produce pollen, ears of native corn occasionally being found which show more or less evidence of having been fertilized by dent pollen. The problem now is to select the best of these acclimatized crosses and breed from them in the hope of fixing a type which will combine the long ears and deep kernels of the dent type with the heavy husk of the native flint. This work was commenced at the Estación Experimental Agronomica, thirty of the best obtainable ears being selected and planted in different rows. The plants in each row, *i.e.*, those from a single ear, were fairly uniform in character, but among the different rows there was a most interesting diversity in vigor and height of stalk, productiveness, shape and size of ears, and in time of maturing.

The future of Cuban plant breeding cannot fail to be of interest. In few tropical countries are the opportunities more numerous and the conditions more favorable. That the Cubans themselves are awakening to the value of this work is demonstrated by the increasing amount of attention being devoted to it at the Estación Experimental Agronomica under the present administration,[4] and it is to be hoped that a great deal will be done by the planters themselves, some of whom are in a position to accomplish important results with the expenditure of very little time and energy, because of the wealth of material which exists all about them.

[4] The Cuban Secretary of Agriculture has recently had a report made on the importance of plant breeding, which it is hoped will lead to the commencement of extensive projects. In this report, written by Armando Lora, the establishment of a new station for plant breeding alone is urged.

Genetic Study of Apples

Apple breeding was begun at the New York experiment station (Geneva) in 1898–99; 148 seedlings of the crosses then made have fruited and have been described in Bulletin 350 of this station. With the exception of these, work with apples is still in an early stage, but further results are soon to be expected, as 1,200 seedlings are now ready to fruit. In addition to these about 2,500 seedlings will be planted in experimental orchards in the next two years. It is hoped that this number of seedlings will enable the investigators to analyze the genetic characters of the parents which have been used. Self-seedlings, because of lack of vigor, have not proved desirable from a horticultural standpoint and since so much time and effort is involved in the growing of apple seedlings, it has not seemed desirable to use selfing as a means of studying the parents. The data from these seedlings should throw light on the inheritance of skin and flesh color, form and size of fruit, season of ripening and quality.

REBUILDING THE LEGHORN

IT IS only about three-quarters of a century since the domestic fowls of Italy were brought to the United States and formed the basis of the Leghorn breed. In their native home they were, and are, largely mongrel in character, with various colors of plumage, legs, face and ear-lobes. Taken up by expert breeders in this country, they gave rise to eight standard and four non-standard varieties, of which the Single Comb White and Single Comb Brown are by all odds the most important, commercially.

From America the Leghorn was taken to Germany, where it goes under the name of Italian. Here, too, it was taken up by artists in breeding, but they were unable to produce the great egg yield for which the breed is noted in America, according to Professor Ehlers of Hanover, who describes the situation in the Mitteilungen of the Deutsche Landwirthschafts-Gesellschaft for October 9, 1915.

A prolonged test at the experiment station of Maryland resulted in egg yields averaging 171 in the first year the hens laid, 149 in the second year, and 115 in the third year. At the New York station, a flock maintained for some time gave 144 eggs as its highest yearly production and 132 as its lowest.

Citing these figures, Professor Ehlers says they cannot be equaled by German Leghorns. It is evident to him, therefore, that the capacity for high egg yield must be elsewhere than in the high comb with carefully incised teeth, the long wattles, the great white ear-lobes and the fancy feather patterns, on which the German breeders have spent so much energy.

Dissatisfaction with the behavior of the Leghorns has led, he reports, to a feeling that the breed should be made over into a typical German breed, possessing a rose comb and short wattles, which will in his opinion give it a smarter appearance. By the introduction of new blood, it is hoped to increase the egg yield. He does not say what new blood is being used: in the United States the Hamburg has been the breed employed in the production of the rose comb Leghorns which are fairly widespread.

CHANGE WELL UNDER WAY

This German undertaking, Professor Ehlers writes, "has secured the approval and support of the Board of Agriculture in the Rhine province, and the director of the winter school in Hermeskeil has had since the year 1912 two flocks each consisting of a dozen hens and a cock, which he has carefully and intelligently bred to the point of fixity, with most satisfactory results. When this undertaking is carried to its conclusion, the Italian race will have become a pure German race with higher productivity, just as the Leghorn has become a definite and superior American race.

"To Director Barth belongs the honor of having produced and disseminated a 'first class' genuine German fowl, a general purpose breed with regular, well-developed bodily form and pure color. In its general appearance it recalls the old and unfortunately extinct Alsatian breed. At the exhibition of the German Agricultural Association in Strassburg, 1913, a first prize and gold ring were given to one cock in recognition of this achievement in breeding, and at the circuit fair in Hanover, 1914, first prize again gave recognition to its supremacy in egg production. At high altitudes, where

Year	Number of hens	Number of eggs laid	Average per hen	Average weight of egg
1910.....	8	1,018	127	54 gr.
1911.....	11	1,463	133	56
1912.....	18	2,482	138	59
1913.....	24	3,667	152	63
1914.....	26	4,019	154	65

THE ITALIAN FOWL IN AMERICA

Single Comb White Leghorn Cockerel bred at the Bureau of Animal Industry Experimental Farm, Beltsville, Md. This is perhaps the most popular breed for egg production in the United States. In Germany, according to Professor Ehlers, the breeders have spent all their time on developing fancy points, and have failed to raise the egg yield. It is therefore proposed to rebuild the breed in Germany, making from it a distinctively German breed with rose comb. Photograph from the United States Department of Agriculture. (Fig. 16.)

the single comb and wattles are likely to freeze in cold weather, the rose-comb breed has proved particularly valuable. Farmers praise its usefulness, its hardiness, and its egg yield, even where the single comb is at its best. As to the egg production of his breed, Director Barth gives statistics [found on page 569].

"The figures show that as the breeding continues, the egg yield of the fowls continues to increase pretty steadily, not only in number laid but in weight of each individual egg. In the last year reported, we have figures that exceed all expectations and are but little short of the figures reported by experiment stations in the United States."

The JOURNAL *of* HEREDITY

(Formerly the American Breeders' Magazine)

A MONTHLY PUBLICATION DEVOTED
TO PLANT BREEDING, ANIMAL BREEDING AND EUGENICS

PUBLISHED BY THE
AMERICAN GENETIC ASSOCIATION
(Formerly called the American Breeders' Association)

VOLUME VI

WASHINGTON, D. C.
1915

Requirements *for* Membership

SUBJECT to the approval of the council, any person interested in the improvement of the human race or the creation of better plants and animals is eligible for membership. The Secretary will be glad to correspond with those interested, and to send a copy of the magazine for examination. Annual dues giving the right to attend the annual and other meetings, and to receive the magazine, are $2.00; for life membership $50.00. Address all communications to the Secretary.

American Genetic Association
511 Eleventh Street N. W., Washington, D. C.
UNITED STATES OF AMERICA

INDEX TO VOLUME VI

THE JOURNAL OF HEREDITY, 1915

A

Age for Marriage, The Proper (A Review), 39
A. G. A., Annual Meeting of, 256
A. G. A., Berkeley Meeting of, 445
America, The Peopling of. Ales Hrdlicka, 79
American Pet Stock Standard of Perfection. J. Henri Wagner (A Review), 541
Ancestry of the Goat, 519
Animal Breeding, Report of Committee on, 21
Annual Meeting of A. G. A., 256
Apples Bloom Late? Why do, 472
  Breeding in Idaho. C. C. Vincent, 453
  Bud Selection in, 356
  Bud Selection in. C. J. Crandall, 277
  Genetic Study of, 568
  Heredity in, 226
  of the Cordilleras. Walter Fischer, 357
  Statistics, Some, 528
Association, Annual Meeting of the, 108, 322
Ayrshires, Black and White. A. H. Kuhlman, 314
Aztec Narcotic, An. W. E. Safford, 291

B

Babcock, E. B., A New Walnut, 40
Bailey, L. H., War and Biology, 51
  and Gilbert, A. W. Plant Breeding (A Review), 181
Bark Breathes, How the, 490
Barrows, W. M., and Phillips, J. McI. Color in Cocker Spaniels, 387
Barley, Breeding Hardier Winter, 168
Barred Pattern in White Fowls, 218
Baur, Prof. Dr. Erwin. Einführung in die experimentelle Vererbungslehre (A Review), 78
Bean, Heredity in the Soy, 461
Bean, The Georgia Velvet. John Belling, 290
Beet Seed, Single Germ. C. O. Townsend, 351
Belling, John. Conditions of Mendelian Inheritance, 108
  Prepotence in Plant Breeding, 45
  The Chromosome Hypothesis of Heredity, 67
  The Georgia Velvet Bean, 290
Berkeley Meeting of A. G. A., 445
Big Tree Photograph Contest, 383
Billings, W. C. Oriental Immigration, 462
Birds, Propagation of Wild. H. K. Job (A Review), 505
Birth Rate, Wellesley's. R. H. Johnson and Bertha J. Stutzmann, 250
Blakeslee, A. F. Fancy Points vs. Utility, 175
Blossoms, Protecting Pollinated. Dr. W. S. Chapin, 471
Brazil, Cattle of. José Maria dos Reis, 203
Breed? What is a. Orren Lloyd-Jones, 531
Breeding for Energy. Francis Galton, 91
  for Horns. Frank N. Meyer, 96
  Hardier Winter Barley, 168
  Practical Dog. W. Haynes, 264
  in Nebraska, Experimental, 423
  Sugar Beets, 174
Brown, B. S. Influence of Stock on Cion, 152
Bud Selection Fails, 191
  Selection in Apples, 356
  Selection in Apples. C. J. Crandall, 277
  Variation, Would Utilize, 354
Burns, W. A Working Model of Mendelism, 365

C

Cactus, Hardier Spineless. David Griffiths, 182
Cancer in Mice, Inheritability of, 383
Carman, E. S. E. M. East, 65
Cattle, Jersey-Angus. Arthur H. Kuhlman, 68
  Crosses with Zebu, 144
  of Brazil, The. José Maria dos Reis, 203
  in Brazil, Zebu. B. H. Hunnicutt, 195
Cereals, Production of New, 479
Chapin, Dr. W. S. Protecting Pollinated Blossoms, 471
Cherry Blossom, Green Leaf in. David Fairchild, 262
  Breeding, Sweet. V. R. Gardner, 312
  Development of a, 278
  Trees, Pollination of, 144
Chile Pepper, Improving the, 397
Chromosome Hypothesis of Heredity, The. J. Belling, 67
Cion, Influence of Stock on. B. S. Brown, 152
Citrous Fruits, Studies in, 537
Clausen, Roy E. Ettersburg Strawberries, 324
Cocker Spaniels, Color in. W. M. Barrows and J. McI. Phillips, 387
Cockerell, T. D. A. The Marking Factor in Sunflowers, 542
Cofer, Dr. L. E. Eugenics and Immigration, 170
Color in Cocker Spaniels. W. M. Barrows and J. McI. Phillips, 387
Committee on Animal Breeding, Report of, 21
Conditions of Mendelian Inheritance. John Belling, 108
Conference, Race Betterment, 313
Conformation of Cows and Milk Yield, 253
Congress, Pan-American Scientific, 261
Conklin, Edwin Grant. Heredity and Environment in the Development of Man (A Review), 240
  Value of Negative Eugenics, 538
Contest, Big Tree Photograph, 383
  Value of the. W. H. Lamb, 424
Controlled Cotton Breeding, 354
Cook, O. F. Date Palm Allies in America, 117
  Two Classes of Hybrids, 55
Cordilleras, Apples of the. Walter Fischer, 357
Correlation, Studies in, 397
Corriedale Sheep in the United States, 96
Cotton Breeding, Controlled, 354
  Hybrids, Perjugate. C. G. Marshall, 57
  Pure Lines in, 548
Coulter, John M. The Fundamentals of Plant Breeding (A Review), 78
Crandall, C. J. Bud Selection in Apples, 277
Crosses in Tunisia, Zebu. M. Roederer, 201
Crosses with Zebu Cattle, 144
Crossing Wheat Flowers Unprotected after Emasculation. D. W. Frear, 350
Cows and Milk Yield, Conformation of, 253
  and Milk Yield, Physical Conformation of. J. Arthur Harris, 348
Cuba, Plant Breeding in. F. S. Earle and Wilson Popenoe, 558

D

Date Palm Allies in America. O. F. Cook, 117
Davenport, Charles B. A Dent in the Forehead, 163
Dent in the Forehead, A. Charles B. Davenport, 163
Determination of Sex. Leonard Doncaster, 31, 269
Development of a Cherry, 278
Dog Breeding, Practical. Williams Haynes, 264
Doncaster, Leonard. Determination of Sex, 31, 269
Dorsey, M. J. Pollen Sterility in Grapes, 243
Dos Reis, José Maria. The Cattle of Brazil, 203
Double Seeding Petunias. Mrs. Myrtle S. Francis, 456
Dwarf Mutant in Maize, A., 98
Dynamic Evolution. C. L. Redfield. (Reviewed by Raymond Pearl), 254

E

Earle, F. S., and Popenoe, Wilson. Plant Breeding in Cuba, 558
Early Marriage Question, The, 92
East, E. M. E. S. Carman, 65
Editor. Feeblemindedness (A Review), 32
  Genealogy and Eugenics, 372
  Maternal Impressions, 512
  Nature or Nurture? 227
Education and Race Suicide. Robert J. Sprague, 158
Effect of the Popular Sire. Williams Haynes, 494
Effects of Selection, The, 527
Einführung in die experimentelle Verebungslehre. Prof. Dr. E. Baur (A Review), 78
Eldest, Superiority of the. C. Gini, 37
Elizabeth, John and. Jay Gee (A Review), 993
Ellis, H. Race Regeneration and Law, 47
Energy, Breeding for. F. Galton, 91
Environment, Heredity and. E. G. Conklin (A Review), 240
Ettersburg Strawberries. R. E. Clausen, 324
"Eugenic" Laws, More. Dr. W. C. Rucker, 219
Eugenic Legislation. (A Review), 142
Eugenical Family Study, How to Make A, 476

Eugenics and Immigration. Dr. L. E. Cofer, 170
Eugenics and Marriage. L. A. Stone, 493
Genealogy and, 72
Congress Postponed, 31
Genealogy and. The Editor, 372
in the Colleges, 511
New Light on. S. A. Kohs, 446
Putting Over. A. E. Hamilton, 281
Research Association, 256
Value of Negative. E. G. Conklin, 538
Evolution, The Mutation Factor in. R. R. Gates (A Review), 432
Societal. A. G. Keller (A Review), 432
Dynamic. C. L. Redfield (Reviewed by Raymond Pearl), 254
Ewart, J. C. Origin of Shetland Ponies, 20
Experimental Breeding in Nebraska, 423
Extra-Floral Nectaries, 367
Exhibit, A Race Betterment, 56

F

Fairchild, David. Green Leaf in Cherry Blossom, 262
Rosa hugonis, 429
The Mangosteen, 339
Family Study, How to Make a Eugenical, 476
Fancy Points vs. Utility. A. F. Blakeslee, 175
Feeblemindedness. Review by the Editor, 32
in Michigan, Report on, 364
First Born's Handicap, The. Karl Pearson, 332
Fischer, W. Apples of the Cordilleras, 357
Flowers, Inheritance in, 371
Forehead, A Dent in the. C. B. Davenport, 163
Fore-lock, Heredity of White. Newton Miller, 165
Fowls, Barred Pattern in White, 218
Fowls, Xenia in (Review of some recent German Work), 212
Francis, Mrs. Myrtle S. Double Seeding Petunias, 456
Frear, D. W. Crossing Wheat Flowers Unprotected after Emasculation, 350
Frog's Hair, 362
Fruit Breeding in Alaska. C. C. Georgeson, 268
Fundamentals of Plant Breeding, The. John M. Coulter (A Review), 78

G

Gable, Chas. H. The Wild Tomato, 242
Galton, Francis. Breeding for Energy, 91
Garden Gladioli. A. C. Hottes, 499
Gardner, V. R. Sweet Cherry Breeding, 312
Gates, R. Ruggles. On the Nature of Mutations, 99
The Mutation Factor in Evolution (A Review), 432
Gee, Jay. John and Elizabeth (A Review), 493
Genealogy and Eugenics, 72
Genealogy and Eugenics. The Editor, 372
Genealogy, International Congress of, 518
Generation, The Next. F. A. Rhodes (A Review), 397
Genetic Study in Apples, 568
Genetics and Government. W. C. D. and C. D. Whetham, 91
in New Jersey, 371
Live-Stock (Committee Report), 21
Georgeson, C. C. Fruit Breeding in Alaska, 268
Georgia Velvet Bean, The. John Belling, 290
German Zootechny. Georg Wilsdorf (A Review), 109
Gini, C. Superiority of the Eldest, 37
Gladioli, Garden. A. C. Hottes, 499
Goat, Ancestry of the, 519
Government, Genetics and. W. C. D. and C. D. Whetham, 91
Grains, More Profit from, 461
Grape Breeding, 470
Grapes, Improving Native, 366
Pollen Sterility in. M. J. Dorsey, 243
Great Men and How They Are Produced. C. L. Redfield, 249
Green Leaf in Cherry Blossom. David Fairchild, 262
Griffiths, David. Hardier Spineless Cactus, 182

H

Hadley, Philip B. The White Leghorn, 147
Hair, Frog's, 362
Hamilton, A. E. Putting Over Eugenics, 281
Handicap, The First Born's. Karl Pearson, 332
Hardier Spineless Cactus. David Griffiths, 182
Hardy Peaches for Missouri, 277
Harris, J. A. Physical Conformation of Cows and Milk Yield, 348
Hayes, H. K. Tobacco Mutations, 73
Haynes, Williams. Effect of the Popular Sire, 494
Practical Dog Breeding (A Review), 264
Heller, L. L. Reversion in Sheep, 480
Hen That Crowed, A, 482
Hens, Profitable and Unprofitable, 488, 489
Heredity and Environment. E. G. Conklin (A Review), 240
and Sex. T. H. Morgan (A Review), 48
in Apples, 226
in the Soy Bean, 461
of White Fore-lock. Newton Miller, 165
Stammering and, 383
The Chromosome Hypothesis of. J. Belling, 67
Holmes, S. J. Unit Characters, 473
Home-Grown or Foreign Seed, 557
Horns, Breeding for. Frank N. Meyer, 96
Hotel Accommodations at Berkeley, 336
Hottes, Alfred C. Garden Gladioli, 499
Hrdlicka, Ales. The Peopling of America, 79
Hunnicutt, B. H. Zebu Cattle in Brazil, 195
Hybrid Histology, 461
Hybrids, Perjugate Cotton. C. G. Marshall, 57
Two Classes of. O. F. Cook, 55
Wheat X Rye. Fr. Jesenko, 47

I

Ice Melting From a Twig, 530
Illustration of Inbreeding. D. F. Jones, 477
Immigration, Eugenics and. L. E. Cofer, 170
Oriental. W. C. Bellings, 462
Improving Native Grapes, 366
Improving the Chile Pepper, 397
Impressions, Maternal. The Editor, 512
Inbreeding, Illustration of. D. F. Jones, 477
Influence of Stock on Cion. B. S. Brown, 152
Inheritability of Cancer in Mice, 383
Inheritance in Flowers, 371
of a Profile, 541
of Bad Temper, 528
of Sex in Strawberries, 545
Insane and Feebleminded in Institutions in 1910, 364
Insane, Offspring of the. A. J. Rosanoff and Helen E. Martin, 355
International Congress of Genealogy, 518

J

Jersey-Angus Cattle. A. H. Kuhlman, 68
Jesenko, Fr. Wheat X Rye Hybrids, 48
Job, H. K. Propagation of Wild Birds (A Review), 505
Johannsen to Visit America, 151
John and Elizabeth. Jay Gee, 493
Johnson, D. S. Sexuality in Plants, 3
Johnson, Roswell H. Natural Selection in War, 546
and Stutzmann, Bertha J. Wellesley's Birth Rate, 250
Jones, D. F. Illustration of Inbreeding, 477
Jordan, D. S., and Jordan, H. E. War's Aftermath (A Review), 404

K

Keller, A. G. Societal Evolution (A Review), 432
Kin, The Marriage of. E. Nettleship, 257
Kohs, S. C. New Light on Eugenics, 446
Kraus, E. J. The Self-Sterility Problem, 549
Kuhlman, A. H. Black and White Ayrshires, 314
Jersey-Angus Cattle, 68

L

Lamb, W. H. Value of the Contest, 424
Law, Race Regeneration and. H. Ellis, 47
Laws, More "Eugenic." W. C. Rucker, 219
Lectures in Eugenics, 162
Leghorn, The White. P. B. Hadley, 147
Rebuilding the, 569
Legislation, Eugenic (A Review), 142
Lewis, C. L. Plant Breeding Problems, 468
Live-Stock Genetics (Committee Report), 21
Lloyd-Jones, Orren. What is a Breed?, 531

M

Macoun, W. T. Plant Breeding in Canada, 398
Maize, A Dwarf Mutant in, 98
Man, Natural Selection in, 497
Mangosteen, The. David Fairchild, 339
Marking Factor in Sunflowers. T. D. A. Cockerell, 542
Marriage, Eugenics and. L. A. Stone, 493
Marriage of Kin, The. Edward Nettleship, 257
Question, The Early, 92
The Proper Age for (A Review), 39
Marshall, C. G. Perjugate Cotton Hybrids, 57
Material for Plant Breeders, 46
Maternal Impressions. The Editor, 512

McHatton, T. H. The Tree that Owns Itself, 526
Melons, Mendelism in, 279
Men, Microbes and. R. T. Morris (A Review), 493
Mendelian Inheritance, Conditions of. J. Belling, 108
Mendelism, A Working Model of. W. Burns, 365
  in Melons, 279
Meyer, Frank N. Breeding for Horns, 96
Mice, Inheritability of Cancer in, 383
Microbes and Men. Robert T. Morris (A Review), 493
Milk Yield, Conformation of Cows and, 253
  Physical Conformation of Cows and, 348
Milk Indications, 350
Miller, Newton. Heredity of White Fore-lock, 165
Morris, Robert T. Microbes and Men (A Review), 493
Morgan, T. H. Heredity and Sex (A Review), 47
Mulattoes in the United States, 311
Mutant in Maize, A Dwarf, 98
Mutation Factor in Evolution, The. R. R. Gates, 432
Mutations, On the Nature of. R. Ruggles Gates, 99
  Tobacco, 73

N

Narcotic, An Aztec. W. E. Safford, 291
Natural Selection in Man, 497
Natural Selection in War. R. H. Johnson, 546
Nature of Mutations, On the. R Ruggles Gates, 99
  or Nurture? The Editor, 227.
Nectaries, Extra-Floral, 367
Negative Eugenics, Value of. E. G. Conklin, 538
Nettleship, Edward. The Marriage of Kin, 257
New Light on Eugenics. S. C. Kohs, 446
New Publication Planned, 504
New Publications: Einfuhrung in die experimentelle Vererbungslehre. Prof. Dr. E. Baur, 78
  Eugenics and Marriage. L. A. Stone, 493
  Heredity and Environment. E. G. Conklin, 240
  Heredity and Sex. T. H. Morgan, 47
  Insane and Feebleminded in Institutions in 1910, 364
  John and Elizabeth. Jay Gee, 493
  Microbes and Men. R. T. Morris, 493
  Plant Breeding. L. H. Bailey and A. W. Gilbert, 181
  Report of Feeblemindedness in Michigan, 364
  Sex, Its Origin and Determination. T. E. Reed, 48
  Societal Evolution. A. G. Keller, 432
  The American Pet Stock Standard of Perfection. J. H. Wagner, 541
  The Fundamentals of PlantBreeding. J. M. Coulter, 78
  The Great Society. Graham Wallas, 313
  The Next Generation. F. A. Rhodes, 397
  The Mutation Factor in Evolution. R. R. Gates, 432
New Walnut, A. E. B. Babcock, 40
Next Generation, The. F. A. Rhodes, 397
Nurture? Nature or. The Editor, 227
Nut-Bearing Trees, Seeks to Find Best, 498

O

Offspring of the Insane. A. J. Rosanoff and Helen E. Martin, 355
Orange, Washington Navel. A. D. Shamel, 435
Oriental Immigration. W. C. Billings, 462
Origin of Shetland Ponies. J. C. Ewart, 20

P

Palm, The South American Traveler's, 384
Pan-American Scientific Congress, 261
Peaches for Missouri, Hardy, 277
Pearl, Raymond. Dynamic Evolution (A Review), 254
Pearson, Karl. The First Born's Handicap, 332
Pedigreed Seeds, To Grow, 181
Peopling of America, The. Ales Hrdlicka, 79
Pepper, Improving the Chile, 397
Perjugate Cotton Hybrids. C. G. Marshall, 57
Perkins, Lindsay S. The Pomerange, 192
Persimmon Tree, An Unusual, 525
Petunias, Double Seeding. Mrs. Myrtle S. Francis, 456
Physical Conformation of Cows and Milk Yield. J. A. Harris, 348
Photographs of Large Trees, 407
Plant Breeders, Material for, 46
Plant Breeding. L. H. Bailey and A. W. Gilbert (A Review), 181
  Correlations, 151
  in Alabama, 479
  in Canada. W. T. Macoun, 398
  in Cuba. F. S. Earle and W. Popenoe, 558
  in Maryland, 403
  in Michigan, 403
  in Minnesota, 472
  in South Carolina, 428
  Prepotence in. J. Belling, 45
  Problems. C. L. Lewis, 468
  The Fundamentals of. J. M. Coulter (A Review), 78
Plants, Sexuality in. D. S. Johnson, 3
Pollen Sterility in Grapes. M. J. Dorsey, 243
Pollination of Cherry Trees, 144
Pomerange, The. L. S. Perkins, 192
Ponies, Origin of Shetland. J. C. Ewart, 20
Poultry Breeding. R. B. Slocum, 483
Practical Dog Breeding. W. Haynes (A Review), 264
Prepotence in Plant Breeding. J. Belling, 45
Prepotency. E. N. Wentworth, 17
Problem, The Self-Sterility. E. J. Kraus, 549
Production of New Cereals, 479
Profile, Inheritance of a, 541
Profit from Grains, More, 461
Profitable and Unprofitable Hens, 488, 489
Propagation of Wild Birds. H. K. Job (A Review), 505
Proper Age for Marriage, The (A Review), 39
Protecting Pollinated Blossoms. W. S. Chapin, 471
Publication Planned, New, 504
Pure Lines in Cotton, 548
Putting Over Eugenics. A. E. Hamilton, 281

R

Race Betterment Conference, 313
Race Betterment Exhibit, A, 56
Race Regeneration and Law. H. Ellis, 47
Race Suicide, Education and. R. J. Sprague, 158
Raspberry Breeding, 191
Rebuilding the Leghorn, 569
Redfield, C. L. Dynamic Evolution (Review by R. Pearl), 254
  Great Men and How They Are Produced, 249
Redfield Offer Remains Open, 157
Redfield's Offer Still Open, 487
Reed, Thomas E. Sex, Its Origin and Determination (A Review), 48
Reversion in Sheep. L. L. Heller, 480
Rhodes, Frederick A. The Next Generation, 397
Richardson, A. E. V. Wheat Breeding, 123
Riddle, Oscar (Review by), 48
Roederer, M. Zebu Crosses in Tunisia, 201
Rosa hugonis. David Fairchild, 429
Rosanoff, A. J., and Martin, Helen E. Offspring of the Insane, 355
Rucker, W. C. More "Eugenic" Laws, 219
Rye Hybrids, Wheat X. Fr. Jesenko, 47

S

Safford, W. E. An Aztec Narcotic, 291
Seed, Home-Grown or Foreign, 557
Selection, The Effects of, 527
Self-Sterility Problem, The. E. J. Kraus, 549
Sex, Determination of. Leonard Doncaster, 31
Sexuality in Plants. D. S. Johnson, 3
Shamel, A. D. Washington Navel Orange, 435
Sheep, Reversion in. L. L. Heller, 480
Shetland Ponies, Origin of. J. C. Ewart, 20
Single Germ Beet Seed. C. O. Townsend, 351
Sire, Effect of the Popular. W. Haynes, 494
Slocum, Rob R. Poultry Breeding, 483
Societal Evolution. A. G. Keller, 432
Society, The Great. Graham Wallas, 313
South American Traveler's Palm, The, 384
Soy Bean, Heredity in the, 461
Sprague, R. J. Education and Race Suicide, 158
Stammering and Heredity, 383
Sterility in Grapes, Pollen. M. J. Dorsey, 243
Stock on Cion, Influence of, 152
Stock Standard of Perfection, The American Pet. J. H. Wagner (A Review), 541
Stone, L. A. Eugenics and Marriage, 493
Strawberries, Ettersburg. R. E. Clausen, 324
  Inheritance of Sex in, 545
Studies in Citrous Fruits, 537
Studies in Correlation, 397
Success with Sugar Cane, 354
Sugar Cane Breeding, 354
Sugar Cane, Success with, 354
Sunflowers, The Marking Factor in. T. D. A. Cockerell, 542
Superiority of the Eldest. C. Gini, 37
Sweet Cherry Breeding. V. R. Gardner, 312

T

Temper, Inheritance of Bad, 528
Tobacco Mutations. H. K. Hayes, 73

Tomato, The Wild. C. H. Gable, 242
Townsend, C. O. Single Germ Beet Seed, 351
Tree, An Unusual Persimmon, 525
Tree That Owns Itself, The. T. H. McHatton, 526
Trees, Pollination of Cherry, 144
Trees, Photographs of Large, 407
Trees, Seeks to Find Best Nut-Bearing, 498
Two Classes of Hybrids. O. F. Cook, 55

U

Unit Characters. S. J. Holmes, 473
Utility, Fancy Points vs. A. F. Blakeslee, 175

V

Value of Negative Eugenics. E. G. Conklin, 538
Value of the Contest. W. H. Lamb, 424
Variation in Pure Lines. C. V. Williams, 452
Vincent, C. C. Apple Breeding in Idaho, 453

W

Wagner, J. H. The American Pet Stock Standard of Perfection, 541
Wallas, Graham. The Great Society (A Review), 313
Walnut, A New. E. B. Babcock, 40
War and Biology. L. H. Bailey, 51
  Natural Selection in. R. H. Johnson, 546
War's Aftermath. D. S. Jordan and H. E. Jordan (A Review), 404
Washington Navel Orange. A. D. Shamel, 435
Wellesley's Birth Rate. R. H. Johnson and Bertha J. Stutzmann, 250
Wentworth, E. N. Prepotency, 17
What is a Breed? Orren Lloyd-Jones, 531
Wheat Breeding. A. E. V. Richardson, 123
Wheat X Rye Hybrids. Fr. Jesenko, 48
Whetham, W. C. D. and C. D. Genetics and Government, 91
White Fore-lock, Heredity of. Newton Miller, 165
White Fowls, Barred Pattern in, 218
White Leghorn, The. Philip B. Hadley, 147
Williams, C. V. Variation in Pure Lines, 452
Wilsdorf, Georg. German Zootechny, 109
Working Model of Mendelism, A. W. Burns, 365

X

Xenia in Fowls (Review of some recent German Work), 212

Z

Zebu Cattle, Crosses with, 144
Zebu Cattle in Brazil, B. H. Hunnicutt, 195
Zebu Crosses in Tunisia. M. Roederer, 201
Zootechny, German. Georg Wilsdorf (A Review), 109

PERIODICAL ROOM
RECEIVED
NOV 29 1915
UNIV. OF MICH.
LIBRARY

The JOURNAL OF HEREDITY

A monthly publication devoted to
Plant Breeding, Animal Breeding
and Eugenics.

DECEMBER, 1915

ICE MELTING FROM A TWIG

WHAT IS A BREED? - - - - - - - Orren Lloyd-Jones

VALUE OF NEGATIVE EUGENICS - Edwin G. Conklin

THE MARKING FACTOR IN SUNFLOWERS
T. D. A. Cockerell

NATURAL SELECTION IN WAR - Roswell H. Johnson

THE SELF-STERILITY PROBLEM - - - E. J. Kraus

PLANT BREEDING IN CUBA
F. S. Earle and Wilson Popenoe

REBUILDING THE LEGHORN

TITLE PAGE AND INDEX TO VOL. VI

ORGAN OF THE
AMERICAN GENETIC ASSOCIATION, Washington, D.C.
Printed for Circulation among Members Only